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DOCUMENT IDENTIFICATION

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15 OCT 1996

AFMC-TM-96-9002

MINUTES OF AIRCRAFT/ RUNWAY DEICING/ANTI-ICING TECHNOLOGY CROSSFEED

AL BACA
CARROLL HERRING

HQ AFMC/ENBE
4375 CHIDLAW ROAD, SUITE 6
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SEPTEMBER 1996

FINAL REPORT FOR 08/20/96 -- 08/21/96

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DIRECTORATE OF ENGINEERING AND TECHNICAL MANAGEMENT
AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OH 45433-5006

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REPORT DOCUMENTATION PAGE

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OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE SEP 1996

3. REPORT TYPE AND DATES COVERED FINAL 08/20/96--08/21/96

4. TITLE AND SUBTITLE MINUTES OF AIRCRAFT/RUNWAY DEICING/ ANTI-ICING TECHNOLOGY CROSSFEED

5. FUNDING NUMBERS
C - - -
PE 78054
PR
TA
WU

6. AUTHOR(S) AL BACA
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER
TCF9601

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AFB OH 45433-5006

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFMC-TM-96-9002

11. SUPPLEMENTARY NOTES TECHNOLOGY CROSSFEED WAS CONDUCTED IN SUPPORT OF THE AIR FORCE DEICING/ANTI-ICING WORKING GROUP STRATEGY DEVELOPMENT EFFORTS.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
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12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

THE AIRCRAFT/RUNWAY DEICING/ANTI-ICING TECHNOLOGY CROSSFEED WAS CONDUCTED BY THE AIR FORCE DURING 20-21 AUG 1996 IN ARLINGTON VIRGINIA. IT WAS A JOINT SERVICE AND INDUSTRY MEETING DEVOTED TO THE CROSSFEED OF INFORMATION OR ENVIRONMENTALLY FRIENDLY DEICING AND ANTI-ICING TECHNOLOGIES. THE MEETING WAS OPEN TO TECHNOLOGY MANUFACTURERS AND VENDORS. IT WAS DESIGNED TO IDENTIFY VARIOUS TYPES OF TECHNOLOGIES WHICH HAVE POTENTIAL FOR USE BY AIR FORCE TO MEET THE INCREASED CONTROLS AND RESTRICTIONS BEING IMPOSED BY THE CLEAN WATER ACT.

14. SUBJECT TERMS

15. NUMBER OF PAGES 0

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

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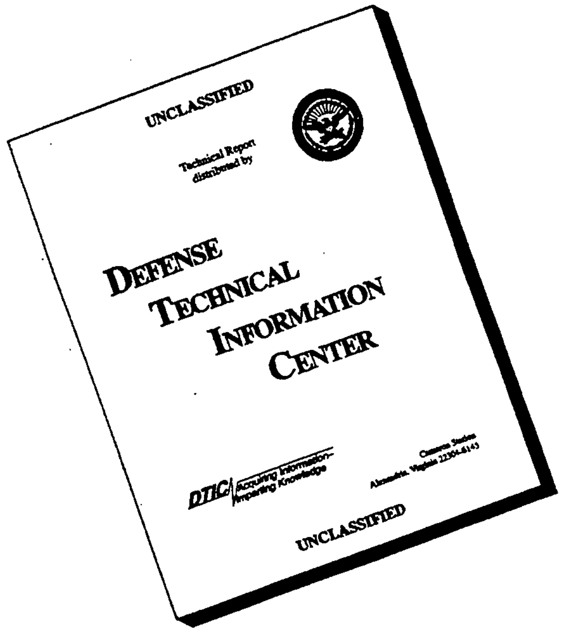

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FROM: HQ AFMC/ENBE
4375 Chidlaw Road, Suite 6
Wright-Patterson Air Force Base, Ohio 45433-5006

SUBJECT: Aircraft and Runway Dicing/Anti-icing Technology Crossfeed

1. During 20-21 August 1996, AFMC conducted a joint service and industry meeting devoted to the crossfeed of technology information pertaining to aircraft and runway de-icing and anti-icing operations. The meeting was designed to identify technologies which have potential for use by the Air Force to meet the increased controls and restrictions imposed by the Clean Water Act.

2. The crossfeed meeting was held in Arlington, Virginia in conjunction with the annual Aircraft and Airfield De-icing Conference and Exposition. The crossfeed meeting consisted of government and industry briefings and subsequent discussions. The first day included such topics as experiences with military and commercial fluids, the results of various de-icing technology studies, the status of research, development and testing efforts, as well as implementation efforts and success stories by various military activities. The last half day was devoted to technology briefings by industry, all of which provided information about various types of de-icing technology. The briefings covered aircraft and runway de-icing technologies, chemicals used, and capturing, recycling and treatment methods.

3. An effort was made to capture the technology information in a comprehensive set of minutes for distribution to Air Force activities. The minutes are at Attachment 1.

4. Our de-icing point of contact is Carroll Herring, HQ AFMC/ENBE, DSN 787-6448.

FOR THE COMMANDER

Gilbert M. Wendt

GILBERT M. WENDT, LT COL, USAF
Chief, MEB Environmental Integration Branch
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Attachment:
Minutes

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Minutes

De-icing and Anti-icing Technology Crossfeed Meeting

1. MEETING LOCATION: ANSER
Suite 800
1215 Jefferson Davis Hwy
Arlington VA (Crystal City)

2. MEETING DATES: 20-21 August 1996

3. PURPOSE OF THE MEETING:

The purpose of the technology crossfeed meeting was to exchange information on aircraft and runway de-icing and anti-icing technologies and to identify those technologies which are potentially useful to Air Force activities in meeting the storm water runoff controls and restrictions imposed by the Clean Water Act. The Crossfeed was planned to support the Air Force de-icing and anti-icing working group's effort to develop a strategy for future environmentally sound de-icing and anti-icing operations which would allow achievement of the Air Force flying mission and could be executed without an excessive drain on financial resources. It was also intended to provide Air Force environmental managers, runway managers, and weapon system managers with insight into compliant de-icing and anti-icing processes in order for them to make the right management decisions in regards to Air Force de-icing operations. This is especially true since standard Air Force de-icing processes do not appear possible, but rather, the de-icing solution at each base appears to have to be site specific; *i.e.,* dependent on factors such as local law requirements, geographic location, temperature, topography, amount of precipitation and whether that precipitation is rain, freezing rain, sleet or snow.

4. DISCUSSION:

The crossfeed consisted of a series of presentations by various government and industry representatives who are knowledgeable in the development, evaluation and use of the various de-icing and anti-icing technologies. The briefings covered aircraft and runway de-icing and anti-icing technologies, including alternative chemicals and processes; new efficient equipment; capture and recycle technologies; and, treatment techniques. There were also summaries of the findings from de-icing technology studies; the results of new product and process test and evaluation efforts; a brief look at RDT&E; and, reports on successful implementation efforts.

In the past, the Air Force primarily used ethylene glycol for aircraft de-icing and urea or glycol mixtures for runway de-icing. Currently, The Air Force is using more environment friendly chemicals such as propylene glycol for aircraft de-icing and potassium acetate for runways. However, increasingly more strict discharge limits from Clean Water Act amendments and NPDES permits is requiring Air Force activities to seek out additional affordable, effective solutions. It is therefore imperative that the Air Force investigate other technologies and chemicals which may further reduce the negative environmental impacts of de-icing and anti-icing operations.

Many sources of technical information exist. Several studies have been initiated by Air Force organizations to identify de-icing and anti-icing technologies. New products and technologies are being evaluated at various sites. Some activities have acquired and implemented new technologies. This technology crossfeed meeting brought together activities that have technology information and activities that need technology information. Crossfeed attendees were provided with an opportunity to assess the availability of technologies and to have face-to-face discussions with the briefers to discuss pertinent issues and to clarify fine points of concern.

This joint service and industry de-icing and anti-icing technology crossfeed meeting was scheduled after the annual Aircraft and Airfield De-icing Conference and before the Air Force's de-icing and anti-icing working group strategy development session. The crossfeed meeting consisted of one and one half days of technology presentations. One day was devoted to presentations by government personnel. One half day was devoted to presentations by vendors and manufacturers of de-icing and anti-icing technologies. Companies invited to make a presentation to the Air Force during the "industry half day" were asked to discuss how the various types of available technologies could benefit the Air Force.

We advised individuals planning to attend the Air Force crossfeed to first attend the Annual Aircraft and Airfield De-icing Conference to gather ideas and information on de-icing technologies and applications. The intent was to use what was presented and discussed at the annual conference to the Air Force advantage during the following Crossfeed and Work Group meetings.

5. PRESENTATIONS:

The crossfeed agenda is provided at attachment 1. A brief summary of each presentation, whether provided by government or industry, is provided in the following paragraphs. More detailed information on each briefing is included in attachment 3. We asked each briefer to provide copy of his or her briefing charts. We also asked the briefers to synopsize their presentation for us. All the materials provided by the briefers to us are in the attachment. We recommend that you review all the materials in the attachment.

- **Crossfeed Objective** **AFMC/ENBE**

Mr. Carroll Herring covered the Crossfeed Objectives and went over the agenda. Mr. Herring stated that the purpose of the crossfeed meeting was to present an overview of the available technologies to interested parties while assembling a reference document as a permanent record to assist those Air Force individuals who would be working the individual problems. In this regard, one of the most important things we did was to develop a compendium of government and industry personnel who are knowledgeable in de-icing to be a point of departure for the individuals working the de-icing problems to talk to. The list is included in the minutes.

- **Commercial Specs** **SAE G-12 Fluids Committee**

This briefing was presented by Ms Jane Hinkle of Octagon Process in her capacity as Secretary of the SAE G-12 Committee. Ms Hinkle told us about the work of the G-12 committee regarding de-icing fluids. The G-12 Committee was established as an ad hoc group but in 1992 became a permanent SAE standing committee. Membership has grown from the original dozen or so to in excess of 300 people. In regards to de-icing the committee is charged with writing the international de-icing fluids specifications which they do in full cooperation with the European Committees. Since the Air Force is serious about embracing the Commercial fluid specifications, we had Ms Hinkle tell us about the SAE commercial specifications as well as about how the SAE fluids compare with the ISO and European fluids. Ms Hinkle also explained how the commercial fluids differ from the mil spec fluids.

- **Mil Type De-icing Fluid Specs** **Navy (Pax River)**

This briefing was presented by Phil Bevilacqua of Pax River NAS. The Navy owns the de-icing military specifications and we wanted to hear the Navy perspective since the Navy does not appear to want to embrace the commercial specs to the extent that the Air Force does. We were told that the Navy was reluctant to accept the SAE AMS 1424 and AMS 1428 standards because the specs do not allow the base material to be specified, do not have strict corrosion requirements, and may cause procurement problems due to incompatible formulations from different manufacturers.

- **AFRES Pilots' Experiences** **317AS/DOLT**

This briefing was presented by Capt. Dave Arthur and Maj. Pedro Rivas, a couple of AFRES C-17 pilots who fly commercial airliners in their civilian jobs. Their briefing was well received as obviously both men had a wealth of experience and provided tremendous insight about the frustrating de-icing problems which they encounter as Air Force pilots of a super sophisticated aircraft. Their script is provided with their briefing slides.

- **"Off-the-Shelf" Technologies [AFLMA Study] AFMC/ENBE**

As the AFLMA personnel who performed the 1995 study were unable to attend this conference, Mr. Herring presented data extracted from the 1995 AFLMA de-icing study. The study reviewed "off the shelf" technologies and the report identified de-icing technologies which were in use by military and civil aviation as well as those technologies which showed potential for efficient, more environment friendly, de-icing. Several of the technologies described in the report were briefed by industry during the industry half day portion of the crossfeed.

- **Literature and Technology Review [ACC Study] HSC/YAL & AL/OEBW**

This briefing was a presentation summarizing an on-going ACC study to evaluate aircraft and runway de-icing at 19 ACC bases for application of de-icing technologies. A synopsis of the briefing is included with the briefing charts.

- **COTS and R&D Information [HSC Study] Labat-Anderson Inc.**

This briefing summarized an HSC study into understanding de-icing technical needs (TNs) 914, 918, 2501 and 2504 and to identify technologies which could meet those needs. The study addressed the subject of aircraft and ground (e.g., runway and roadway) de-icing. The objectives were twofold to identify commercial products, procedures, and infrastructure changes relative to de-icing; and, to identify commercial and governmental research into de-icing. Needs statements were reviewed for characteristics, similarities and differences and a criteria was developed for analyzing potential solutions. A compendium of current commercial products and research efforts, including information on technology vendors, applications, and costs was developed. This information is included with the briefing charts.

- **Introduction to Clean Water Act, Permits, etc. AFCEE/CCR-D**

This briefing was an explanation of the Clean Water Act and its enforcement. We were told that de-icing is covered as a "process wastewater" under the NPDES Permit (Individual or Storm Water). De-icing runoff is responsible for significant degradation of waters quality in this country. NPDES permits require Best Management Practices (BMPs) to eliminate, or at least to reduce the de-icing runoff. The criminal penalties (per violation) are as follows: Negligent - $25,000 and 1 year in prison; Knowing - $50,000 and 3 years in prison: Endangerment - $250,000 and 15 years in prison. The civil penalty is $25,000 per day. Therefore, the best advise is to be aware. The Air Force has to be sensitive to local demands and concerns. Ignorance of the law is no excuse.

- **De-icing / Anti-icing Technologies and Case Studies NDCEE**

This briefing summarized the alternative technologies, materials, and operational procedures for both aircraft and runway de-icing as identified in two Air Force reports:

"Report on the Requirements Analysis for De-icing" (Draft version dated June 28, 1996) by the Human Systems Center (HSC/XRE) of Brooks AFB, TX, and "Exploring available De-icing Technologies" (October 1995) by the Air Force Logistics Management Agency (AFLMA). NDCEE also surveyed various airports, military bases, and airline companies for what they were doing in regards to de-icing practices. NDCEE then combined the technical information they extracted from the two studies and from other sources available to them with their inquiry into the de-icing practices at the various locations they surveyed to relate technologies to factors. This useful information can guide individuals during technology selection processes to identify the technology which meets their specific requirements.

- **Basic Research** **AFOSR/NL**

Dr. Hedberg told us that the Air Force Office of Scientific Research is currently supporting basic research programs relating to de-icer and anti-icer chemistry as a key component of its thrust on alternative materials and processes for hazard free operations and maintenance. Examples would be cold weather insect and fish protein research and the use of ground cover root systems to assist with natural degradation. Computational chemistry is being used for the first time to better understand the chemical mechanism of freezing point depression, and to guide selection of optimized molecular structure. Some of this research is being performed by various colleges and universities. Other research is being done at the various Air Force laboratories.

- **Development of New Anti-icing Product** **Wright Lab**

This briefing was a joint Wright Lab and NASA Ames presentation. The introduction was provided by Lt Udo-Aka of Wright Lab who gave a short presentation on de-icing and anti-icing R&D needs. De-icing and anti-icing R&D needs are divided into two major categories: aircraft needs and runway and pavement needs. Wright Lab is the OPR for the aircraft needs. Armstrong Lab is the OPR for runway and pavement needs. Industry has taken the lead on runway and pavement de-icing and is actively pursuing alternative de-icing materials. The Air Force does not have R&D projects to support runway and pavement de-icing but is doing test & evaluation to ensure that the alternative materials developed by industry are suitable for Air Force use.

Lt Udo-Aka then turned the podium over to Lt Col Perkins, the Wright Lab liaison to NASA Ames, and to Dr. Zuk and Dr. Haslim of NASA Ames. Wright lab has been cooperating with NASA Ames on an advanced aircraft anti-icer program since FY 1993. The NASA Ames advanced aircraft anti-icer program is developing a propylene glycol-based anti-icer with significantly extended holdover times (qualified at 118 minutes). By providing better protection against icing, the advanced anti-icer will allow the Air Force to use less propylene glycol, thereby reducing the environmental impact.

Wright Lab is striving to qualify anti-icers for Air Force use during the 96-97 snow season. WL/MLS concluded that its material compatibility tests on commercial Type II anti-icers last June met the AMS 1428 specification. All tests conducted produced satisfactory results. Therefore, AMS 1428 (Type II anti-icers) is in the process of being adopted for Air Force use during the 96-97 snow season. The preliminary adoption notice was released in July.

- **Toxicity Testing of New Products** **OL AL HSC**

This briefing pertained to the DOD toxicology program. Toxicology was defined and related to the risk assessment process. The presentation continued with an explanation of the chemical risk assessment process and the need for health-based approaches to identify and characterize potential hazardous substances. A brief overview of toxicity screens and tests was presented to make toxicity data more meaningful. The presentation included an explanation of tri-service toxicology and identified the toxicology points of contact in the other services. Please refer to Dr. Mattie's briefing slides and synopsis for additional information.

- **Runway De-icing Technologies and Chemicals** **AFCESA**

This briefing pertained to the Air Force runway and taxiway de-icers. Sgt. Labonte talked about currently approved runway de-icing technologies and chemicals plus those that may be on the horizon. He explained how the Air Force has gone about reducing harmful de-icers such as urea and ethylene glycol. He also summarized the results of the sodium acetate test at Elmendorf AFB and the sodium formate test at Minot AFB. The briefing included an explanation of the Runway Ice Detection System and touched briefly on advances on mechanical cleaning of runways and mobile sensors to monitor runway temperatures.

- **Introduction to Clean Water Act, Permits, etc.** **AFCEE/CCR-D**

This briefing was an explanation of the Clean Water Act and its enforcement. We were told that de-icing is covered as a "process wastewater" under the NPDES Permit (Individual or Storm Water). De-icing runoff is responsible for significant degradation of waters quality in this country. NPDES permits require Best Management Practices (BMPs) to eliminate, or at least to reduce the de-icing runoff. The criminal penalties (per violation) are as follows: Negligent - $25,000 and 1 year in prison; Knowing - $50,000 and 3 years in prison: Endangerment - $250,000 and 15 years in prison. The civil penalty is $25,000 per day. Therefore, the best advise is to be aware. The Air Force has to be sensitive to local demands and concerns. Ignorance of the law is no excuse.

- **Efficient Deicing Trucks w/Hot Air** **Navy (Lakehurst)**

This briefing was a Navy briefing about what they are doing to procure more efficient de-icing trucks. Essentially, they are tying in with an Air Force contract. Their main concern

is to reduce the amount of glycol applied. One of the things they are doing in this regard is to prototype a hot air system.

AFRES Solution at Niagara Falls — 914 LG

This briefing was a no nonsense briefing given by Col Clune of the Niagara Falls AFRES Base about how changes in operations, management practices and technology can reduce the amount of glycol in storm water runoff. Col Clune has had to solve many frustrating de-icing problems. You are invited to read his briefing notes which he included with his briefing slides. Both contain excellent information.

Note: We also included AFRES BMP guidance with the Col Clune briefing.

- ### AFRES Solution at Pittsburgh IAP — 911 ALW

This briefing by Pittsburgh IAP-ARS (AFRES) discussed the regulatory actions by the State of Pennsylvania Department of Environmental Resources that led to the creation of a de-icing pad and collection system on the base. The design and implementation of this system, as well as its timeliness, were also discussed. The synopsis of the briefing and the briefing charts are in the attachment.

- ### Holding Pond for Milwaukee ANG Base — 128 ARW

This briefing was a Wisconsin Air National Guard (ANG) briefing about a retention pond that they are planning to capture and treat spent glycol. The Wisconsin ANG determined that a collection pond made the most sense from its perspective. A collection pond stores stormwater with de-icing fluid during the winter, treats the water through natural processes during the spring and summer and discharges the treated de-icing fluid into the stormwater system in the fall.

- ### De-icing Truck Technology Improvements — Landoll & FMC

Tom Joyce of Landoll Corp. along with Dave Phillips and Lee Williams of FMC briefed de-icing truck technology. Of particular interest is the development work being done in the field of forced air technology through a cooperative research agreement with Wright Lab. Development has also been supported by United Airlines and Federal Express. Further development in using this type of system in conjunction with existing de-icing technology is planned for the near future.

Note: Simon Aviation, a manufacturer of de icing equipment, was not able to participate in the crossfeed due to last minute commitments. As a result, Allied Signal and CCSI were added to the agenda as last minute replacements.

- **Forced Air Snow Removal** **Allied Signal**

John Stanko briefed the Allied Signal "Augmented Forced Air De-icing System" which uses a small amounts of fluid. The Allied Signal Centrifuge Compressor and the Allied Signal APU are good air sources because they are compact and can be located near the nozzle for de-icing operations. This simplifies air delivery. The Allied Signal system utilizes high velocity co-axial streams of de-icing fluid and air to overcome the limitations of pure air forced de-icing. (Pure forced air is not effective on wet snow or ice.) Testing of the system begins after Labor Day.

- **Whisper Wash™ De-icing System** **Catalyst & Chemical Services**

John Gaughan briefed that Catalyst & Chemical Services Inc. (CCSI) has designed and patented the "Whisper Wash™", a mobile aircraft de-icing/anti-icing system. The system operates as the aircraft taxis beneath height adjusted boom arms which extend from flatbed trailers over the complete wing area. Pneumatic nozzle groups remove snow and ice from the aircraft via heated compressed air. Hydraulic nozzle groups apply anti-icing fluid to the cleared wing and control surfaces. Flow rates, mix ratios, etc can be manually or automatically controlled based on weather conditions or specific requirements.

- **Radiant Heat** **Process Technologies**

John Chew briefed that Process Technologies Inc. has developed the Infratek™ Pre-Flight De-icing System, an aircraft de-icing system which uses radiant energy as an alternative to glycol. The aircraft is moved into a open-ended hangar and deiced using radiant energy.. Radiant heat melts the ice quickly. Please note that the radiant energy output is carefully matched to the aircraft so that the interior cabin temperature is not affected. In this regard, the FAA is involved in a cooperative research effort to insure that de-icing can occur without impacting the accuracy of the on-board instruments.

- **Efficient Pre-Moist Chem. Spreaders** **Thomsen Products/EPOKE**

Torben Zerlang and Lars Mathiasen briefed EPOKE chemical spreaders for runways. They told us that EPOKE spreaders are in use all over the world. Regarding the pre-moist spreaders, they said that by pre-wetting the solid de-icers, substantial material cost savings are possible and that pre-wetting limits the adverse impact on the environment.

- **Portable Glycol Capture Systems** **Int'l Automated Systems**

Jorgen Bildsoe briefed RO-MAT, a fluid collection system for capturing glycol fluids during de-icing operations. The RO-MAT fluid collection system is a deeply ribbed, steel belted, tough rubber matting which can be installed on a concrete or asphalt apron or taxiway. The collection system is modular and can be deployed if required.

- **Pressurized Water, Vacuum and Clean-Up — Coastal Fluid Technology**

Glenn Vanderlinden briefed recycling and treatment services for spent de-icing fluids and contaminated stormwater. Coastal Fluid Technologies Inc provides a glycol collection and recycling service which is flexible to allow custom solutions. What is done depends on the locale. Ordinarily, pick-up is during the de-icing operation. If the local rules are especially stringent, it may be necessary to make several passes to grab as much glycol as possible. Recycling revenues are used to offset collection and management costs. (Spent EG has about 1/3 the value of spent PG.)

- **Glycol Recovery Vehicles — Vactor Manufacturing Co.**

Steve Baker briefed glycol recovery vehicles which can be used to vacuum glycol and waste water resulting from aircraft de-icing. Vactor Manufacturing manufactures a specially designed truck which is used to efficiently capture as much of the spent fluid as quickly as possible. The truck also has the capability to pick up the residue with a scrub feature.

- **Anaerobic Biofiltration — Biofiltration Systems**

Tom Cannon briefed anaerobic biofiltration. The key is to control bacteria to process specific waste. BioFiltration Systems has developed a process to harness bacteria to specifically treat glycol and associated effluent. The right kind of bacteria is required. Three to four weeks must pass before the bacteria get hungry and start eating glycol. The treatment is done through biofilter media in a tank which means the effluent is put in contact with a bacteria that biodegrades the waste and turns it into methane gas and carbon dioxide.

6. SUMMARY:

We believe that the De-icing and anti-icing Technology Crossfeed was successful. One hundred and sixteen people representing Air Force, Army, Navy, other military and government activities, and industry attended. Technical information on many de-icing and anti-icing technologies was exchanged.

Even though an effort was made to identify and discuss as many technologies as possible in the time available, the crossfeed was not a comprehensive review of all available de-icing and anti-icing technologies. Also, the reader needs to keep in mind that the technologies discussed at the crossfeed meeting and summarized in this report were selected as representing the type of technology available and are not necessarily the best or most desirable technology for Air Force application. The best solution for an Air Force installation is a combination of best management practices and technologies tailored for the specific site depending upon the operational environment at that location as well as the waste water controls and permit requirements for that area.

Military applications are somewhat different from civil aviation. Time spent on the runway between de-icing and takeoff may impact the need for an anti-icing fluid versus a de-icing fluid. Another factor to consider is the proposed location of a de-icing facility if one is planned, or for that matter, exists. What will be the impact of routing all aircraft through a single de-icing pad? Is the base in question located near other large glycol users so that capture and recycling will be cost effective? What are the rules of the waste water treatment plant serving that location?

The volume of glycol used on a specific Air Force base may not justify construction of expensive de-icing pads or allow for installation of an economical capture and recycle system. For a recycling service to be economical, there must be adequate volume and the glycol mixture waste must not be too diluted. Even the mixture of ethylene and propylene glycols in the waste can present a problem in recycling.

In the final analysis, there cannot be a common strategy for all Air Force Bases. Each solution has to be site specific. The solution selected has to consider things such as geography, topography, temperature, precipitation, local law, capability of the local POTW, etc. in addition to the economic considerations and the operational requirements.

These crossfeed minutes should serve as a starting point in any search for the most appropriate aircraft and runway de-icing technologies at an Air Force installation. Aircraft de-icing operations are controlled by aircraft technical orders and by the pilot's flight manual.. Any changes to local de-icing procedures must be approved by weapon system single managers for aircraft based there. There should also be coordination with the single managers who manage aircraft which may land there. Please remember that the single manager of the aircraft landing at a base has the final say about what de-icing materials can be used around his or her airplane. Therefore, please do not forget to coordinate de-icing matters with the weapon system single managers.

Minutes prepared by: Carroll Herring, Action Officer, and Al Baca, Support Contractor

Approved as written:

Gilbert M. Wendt

GILBERT M. WENDT, LT COL, USAF
Chief, MEB Environmental Integration Branch
PM and S&IO MEB Support Division

Attachments
1..Crossfeed Agenda
2. Roster of Attendees
3. Briefings including Synopsis
4. Contact List

Agenda

De-icing Technology Crossfeed
ANSER
1215 Jefferson Davis Hwy Suite 800
Arlington VA (Crystal City)

20 August 1996

1400 - 1405 Welcome **AFMC/ENBE**

1405 - 1410 Administrative **ANSER**

1410 -1425 Crossfeed Objective **AFMC/ENBE**

De-icing and Anti-icing Specifications

1425 - 1450 Commercial Specs **SAE G-12 Fluids Committee**
[Commercial specifications, the different types of fluids, and an SAE G-12 Fluids Committee status report]

1450 - 1510 Mil Type De-icing Fluid Specs **Navy (Pax River)**
[Overview of the military type de-icing fluid specs by Navy Chemical Engineer]

Comparing Military and Civilian De-icing and Anti-icing Operations

1510 - 1530 One Pilot's Experience **317AS/DOLT**
[An AFRES C-17 pilot who flies for American Airlines will compare military and commercial de-icing]

1530 - 1545 15 Minute Break (Please do not exceed 15 minutes

Survey of De-icing Products, Technologies and Chemicals

1545 - 1600 "Off-the-Shelf" Technologies **AFMC/ENBE**
[Summary of the "off the shelf" de-icing/anti-icing products and technologies extracted from the 1995 AFLMA Study]

1600 - 1620 Literature and Technology Review [ACC Study] **HSC/YAL & AL/OEBW**
[Study to evaluate aircraft and runway de-icing at 19 ACC bases for application of de-icing technologies]

1620 - 1645 COTS and R&D Information [HSC Study] **Labat-Anderson Inc.**
[Understanding de-icing technical needs (TNs) 914, 918, 2501 and 2504 and to identify technologies that can meet those needs]

NOTE: Immediately after the previous briefing, there will be a brainstorming session. Those who wish to participate are welcome to stay.

[Before the Air Staff de-icing working group members can develop an environmentally compliant de-icing strategy, they must have a knowledge of what military bases and civilian airports have already done in areas such as operational and procedural changes, best management practices, simple and low cost infrastructure improvements, etc to reduce glycol and other de-icing chemicals in stormwater runoff. This forum is intended to gather these ideas for the De-icing Working Group members. Please stay and participate]

21 August 1996

0800 - 0810 Introduction to Clean Water Act, Permits, etc. **AFCEE/CCR-D**
[An explanation of the Clean Water Act and its enforcement. There will also be an explanation of NPDES and SPDES permits]

Survey of De-icing / Anti-icing Technologies and Chemicals

0810 - 0840 De-icing / Anti-icing Technologies and Case Studies **NDCEE**
[Case studies and technology summaries as they relate to possible Air Force use]

Research & Development Efforts

0840 - 0900 Basic Research **AFOSR/NL**
[Briefing regarding the research at the colleges and universities that AFOSR/NL is sponsoring.]

0900 - 0930 Development of New Anti-icing Product **Wright Lab**
[Briefing on the de-icing research being done by Wright Labs. Includes an explanation of NASA Ames research to provide a more environmentally friendly type II fluid.]

Test and Evaluation of Chemicals and Technologies

0930 - 0945 Toxicity Testing of New Products **OL AL HSC**
[Importance of toxicity testing before new products are authorized for Air Force use]

0945 - 1000 15 Minute Break (Please do not exceed 15 minutes)

1000 - 1015 Runway De-icing Technologies and Chemicals **AFCESA**
1015 - 1025 Results of Sodium Acetate Test **3CE/CEORH**
1025 - 1035 Results of Sodium Formate Test **5CES/CEO**
[Briefing on current runway de-icing technologies and chemicals plus those that may be on the horizon. (eg urea; potassium acetate; sodium formate; calcium magnesium acetate; mechanical de-icing equipment; runway ice detection system; etc.) Also briefings regarding the sodium acetate test at Elmendorf AFB and the sodium formate test at Minot AFB.]

Military Implementation Efforts and Success Stories

1035 - 1100 Efficient Deicing Trucks w/Hot Air **Navy (Lakehurst)**
[Navy perspective on efficient ADAF application reducing the amounts of glycol fluids used]

1100 - 1125 AFRES Solution at Niagara Falls **914 LG**
[How changes in operations, management practices and technology can reduce glycol in storm water runoff]

1125 - 1140 AFRES Solution at Pittsburgh IAP **911 ALW**
[Small capturing and disposal operation]

1140 - 1200 Holding Pond for Milwaukee ANG Base **128 ARW**
[Glycol capture for treatment in a holding pond]

1200 - 1300 Lunch

"Industry Half Day"
Briefings by Industry
New & Innovative Products & Technologies

Aircraft De-icing and Anti-icing Chemicals and Technologies

1300 - 1330	De-icing Equipment and Technologies	Simon Aviation
1330 - 1400	De-icing Truck Technology Improvements	Landoll & FMC
1400 - 1430	Radiant Heat	Process Technologies

Runway De-icing and Anti-icing Chemicals and Technologies

1430 - 1500	Efficient Pre-Moist Chem Spreaders	Thomsen Products/EPOKE
1500 - 1515	15 Minute Break (Please do not exceed 15 minutes)	

Capturing and Recycling Technologies

1515 - 1545	Portable Glycol Capture Systems	Int"l Automated Systems
1545 - 1615	Pressurized Water, Vacuum and Clean-Up	Coastal Fluid Technology
1615 - 1645	Glycol Recovery Vehicles	Vactor Manufacturing Co

Treatment Products and Technologies

1645 - 1715	Anaerobic Biofiltration	Biofiltration Systems

Thank you for participating in the Air Force De-icing Technology Crossfeed. Past experiences with technology crossfeeds clearly indicate that attendee participation in the discussions add significantly to the good of having the crossfeed.

We intend to publish a comprehensive set of minutes of the crossfeed proceedings by 30 Sep 1996. Our hope is that the information in the minutes will be an excellent reference for military people working de-icing problems.

Briefers, please do not forget to provide us with your synopsis and a hard copy of your briefing for inclusion in the minutes.

Carroll Herring
Action Officer

Al Baca
Minutes

ATTENDEES - AIR FORCE CROSSFEED

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19

ATTENDEES - AIR FORCE CROSSFEED

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25	Dalzell	Bob	23CES/CEVC	Pope AFB NC	910-394-1654		
26	De Bor	Wayne	171ARW PA-ANG	3651 Mapleview Dr Pittsburg PA 15012	412-474-7477		
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ATTENDEES - AIR FORCE CROSSFEED

	A	B	C	D	E	F	G
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45	Hedberg	Dr Fred	AFOSR/NL	110 Duncan Ave. Sut B115. Bolling AFB DC 20332	202-767-5024	202-404-7475	fredohedberg@afosr.af.mil
46	Hernardez	Dr Mark	Univ of Colorado at Boulder	Campus Box 428 Dept of CEAE Boulder CO 80302	303-492-5991	303-492-7317	hernande@stripe.colorado.edu
47	Herring	Carroll	AFMC/ENBE	4375 Chidlaw Rd Ste 6, WPAFB OH 45433	DSN: 787-6448	DSN: 986-1650	cherring@wpgate1.wpafb.af.mil
48	Hinebaugh	Larry	Aviation Environmental	4334 S Industrial Rd Ste 400 Las Vegas NV 89103	800-788-6450		
49	Hinkle	Jane	Octagon Process	The Market Place 725 River Rd Edgewater NJ 07020	201-945-9400		
50	Huelsman	1 Lt Bob	128ARW/EM	1723 East range Ave Milwaukee WI 53207			rhuelsman@wimke.ang.af.mil
51	Hunt	Darren	Jacobs Engineering	1600 N 17th St. Arlington VA	703-358-8818	703-358-8822	
52	Husain	Mano	PACAF/CEVC	25E St Ste D-306, Hickam AFB, HI 96853	808-448-0474		husainm@hqpacaf.af.mil
53	Igo	Skip	910 AW VIENNA.OH	Kings Grave Rd Vienna, OH 44473-0910	330-392-1250		
54	Jobes	Maj. Lynn	910 AW/LGM	910 AW/LGM Youngstown AFB, OH 44473	330-392-1144	DSN: 346-1350	ljobes@yng.afres.af.mil
55	Joyce	Tom	Landoll Corp	1900 North St Marysville KA 66508	913-562-5381	913-562-2825	
56	Jozwick	Rick	411 Airlift Wing/MVS	316 Defense Ave Ste 101 Cpraopolis PA 15108	412-474-8189		
57	Kelly	Larry	Octagon Process	The Market Place 725 River Rd Edgewater NJ 07020	201-945-9400		
58	King	John	SA-ALC/TIEM	450 Quentin Rooselute Rd Kelly AFB TX 78241	210-925-7391	210-925-4916	jking@sadis01.kelly.af.mil
59	Koch	Lars	Roullinds Fabriker	Hestehaven 5260 Odenses Denmark	45-63-11-5225	45-63-11-5194	
60	Koehler	Walt	NAWC Aircraft Div	Lakehurst NAS NJ	908-323-7907		

21

ATTENDEES - AIR FORCE CROSSFEED

	A	B	C	D	E	F	G
61	Koehler	Walter	Naval Air Warfare Cen	Hwy 547 LakeHurst NJ 08733	908-323-7907	908-323-1908	
62	Kozumbo	Dr Walt	AFOSR/NL	Bolling AFB DC	202-767-4281		
63	Kull	Michael	Process Technologies	40 Centre Dr. Orchard Park NY 14127	716-662-0022	716-662-0033	
64	Labonte	SMSgt Earl	AFCESA/CEOM	139 Barnes Dr Ste1, Tyndall AFB FL 32403	904-283-6386	904-283-6499	lobontee@afcesa.af.mil
65	Lacourciere	SMSgt Paul	440 AW GMIAP MAO	300 E College Ave. Milwakee WI 53207	414-482-5550		
66	Landry	Maj Mike	NAVAIR PMA-260C21		703-604-3344	703-604-4505	
67	Legarreta	George	FAA (Wash) AAS-100	800 Independence Ave. SW Wash DC	301-267-8766	301-267-5383	
68	Lewandowski	Tom	Ecology & Environment	368 Pleasantview Dr. Buffalo, NY 14068	716-684-8060		tml02@ene.com
69	Locklair	Deborah	USAFE/CEVC	Unit 3050 Box 10 APO OE 09094			locklaid@usafe.ramstein.af.mil
70	Makofsi	Kathy	ANGRC/CEVC	3500 Fetchet Ave. Andrews AFB MD 20762	301-836-8695	301-836-8151	kmakofski@angre.ang.af.mil
71	Malinowski	Tricia	Ecology & Environment	368 Pleasantview Dr. Buffalo, NY 14068	716-684-8060	716-684-0844	pam02@ene.com
72	Masters	Charles	FAA Technical Center	AAR-421 Atlantic City Intl Airport NJ 08405	609-485-4135	609-485-4005	masters@admin.tc.faa.gov
73	Mathiasen	Lars	EPOKE A/S	PO Box 230 6600 VEJEN Denmark			
74	Mattie	Dr David	AL HSC/OET	OL AL HSC/OET 2856 G St WPAFB OH	513-255-5740	513-255-1474	dmattie@al.wpafb.af.mil
75	McDonald	Evelyn	Labat-Anderson	8000 Westpark Dr Ste 400 McClean VA 66508	703-506-9600		
76	McVey	Tami	CNO N457D1	2211 S Clark Place Rm 644 Arlington VA	703-602-9434	703-602-5547	mcveyt@n4.opnav.navy.mil
77	Mongelli	Jerry	AFMC/LG-EV	4375 chidlaw Rd Ste 6 WP AFB OH 45433	513-257-3487	513-257-4244	mongelli@wpgate1.wpafb.af.mil
78	Myers	Cliff	DLA/DSCR-JDT	8000 Jefferson Davis Hwy Richmond VA 23297	DSN: 695-3395	DSN: 695-6008	gst5029@dcsr.dla.mil
79	Nault	Gary	ACC/CEVCM	129 Adrewes St Langley AFB, VA 23665	757-764-3668	757-764-8033	naultg@hqaccce.langley.af.mil
80	Noel	Doug	Ogden Environmental	3325 Perimeter Hill Dr Nashville TN 37211	615-333-0630	615-331-4715	dnoelenc5.infi.net

ATTENDEES - AIR FORCE CROSSFEED

	A	B	C	D	E	F	G
81	Nonaka	Maj. Kent	AFMC/CEVV	4225 Logistics Ave WPAFB OH 45433	513-257-7414	513-486-1650	nonakak@afmcce.wpafb.af.mil
82	Oliver	Jerry	Davison Army Airfield	Ft Belvoir VA	703-806-7218		
83	Owens	Roger	EFX Systems	1300 Shames Dr Westbury NY 11590	516-997-2100	516-997-2129	Rwodp@aol.com
84	Palmer	Pete	SA-ALC/LDEE	485 Quentin Roosevelt Kelly AFB. TX 78241	210-925-0239	210-925-8606	ppalmer@sadis01.af.mil
85	Pantelis	Paul	Aviation Applied Tech Dir	Attn: AMSAT-B-TL FT. Eustis VA 23604	757-878-5777	757-878-3029	pantelis@aatdsi.army.mil
86	Perkins	LTC. Rich	AFLO	MS210-6, NASA-AMES, CA 94035	415-604-5832	415-604-0867	lt_col_rich_perkins@qmgate.arc.nasa.gov
87	Phillips	Dave	FMC	7300 Presidents dr Orlando FL 32809	407-851-3377		
88	Rivas	Maj Pedro	317 AS/DOLT	105 East Hill Blvd Charleston AFB SC	803-566-2436	803-566-5867	
89	Ryerson	Dr Charles	Army Corp Engineer(CRREL)	72 Lyme Rd Hanover NH 03755-1290	601-646-4487		
90	Sandoval	Robert	NFESC Port Hueneme,CA	1100 23rd Ave Port Hueneme, CA 93043	805-982-1466	805-982-4304	bsandov@nfesc.navy.mil
91	Sanghavi	H.	AMC/CEVC	507 A St. Scott AFB IL 62226	618-256-5764	618-256-2693	sanghav@hqafm.af.mil
92	Schmift	Ron	Vactor MFG, Inc.	1621 S. Illinois St. Streator, IL 61364	815-672-3171	815-672-2779	
93	Shah	Jay	USAF/CEVQ	1260 Air Force Pentagon	703-697-2797	703-697-3378	shahj@afce.hq.af.mil
94	Sims	Greg	AMC/DOTK	Bldg 1600 Ste 3A1 Scott AFB IL 62225	618-256-5924	618-256-2273	simsgr@safb.af.mil
95	Spencer	1 Lt Yvonne	HSC/YAL	8107 13th Street Brooks AFB TX	DSN: 240-6354	DSN: 240-2993	spencery@diamond.brooks.af.mil
96	Stanko	John	Allied Signal	2525 W. 190th Torrance CA 90509	310-512-4613	310-512-1589	
97	Stell	Sue	AFRES/CEV	155 2nd St. Robins AFB. GA	912-327-1078	912-327-0108	stell@wrb.afres.af.mil
98	Swindell	Paul	NAWC AD Lake Hurst	Hwy 547 Lake Hurst NJ 08733	908-313-1926	980-313-4029	swindell@lakehurst.navy.mil
99	Thompson	Bobbi	JAYCOR	4035 Col Glenn Hwy Ste 100 Beavercreek OH 45431	513-427-9690	513-427-9673	
100	Tower	John E.	171 ARW/EM	300 Tanker Rd Coraopolis, PA 15108-4257	412-474-7640	412-474-7221	

ATTENDEES - AIR FORCE CROSSFEED

	A	B	C	D	E	F	G
101	Udo-Aka	2 Lt. Ita	WL/MLSE	2179 12th St. Suite1 WPAFB, OH 45433	513-255-3953	513-976-4378	udoakaui@mil.wpafb.
102	Vanderlinden	Glenn	Coastal Fluid Tech Inc.	PO Box 81577. Lafayette, LA 70598-1577	318-261-0796	318-261-0797	glennv@coastalfluid.com
103	Vaselich	Ray	SAF/AQRE	8804 Lake Hill Dr. Lorton VA 22079	703-690-1986	703-690-4572	ravselic@capaccess.org
104	Verma	Vic	AFCEE/CCR-A	77 Forsyth St SW STE 295 Atlanta GA 30335-6801	404-331-0590	404-331-2537	vverma@afceeb1.brooks.af.mil
105	Wall	1 Lt Jack	151 ARW/EM	765 North, 2200 West Salt Lake City UT 84116	801-595-2157	801-595-2178	jwall@utslc.ang.af.mil
106	Webb	Donald	OC-ALC/EMV	7701 2nd St. Tinker AFB, OK	405-734-7071	405-736-4381	dwebb@po25.tinker.af.mil
107	Weiner	Lt Col Allan	AL/EQ	139 Barnes Dr Tyndall AFB FL 32403	904-283-6308	904-283-6064	allan_weiner@ccmail.aleq.tyndall.af.mil
108	Westmark	Carolyn	Foster-Miller, Inc.	195 Bear Hill Rd Walthan, MA 02154	617-684-4119	617-290-0693	cwestmark@foster-miller.com
109	Whitman	David	Aviation Environmental	4334 S Industrial Rd Ste 400 Las Vegas NV 89103	800-788-6450		
110	Williams	Lee	FMC	7300 Presidents Dr Orlando FL 32809	407-851-3377		
111	Yon	ASC(AW) Jack	NAS Brunswick, Maine	1251 Orion St. South Brunswick ME 04011	207-921-2643	207-921-2306	jackyon@jono.com
112	Zachariades	Gus	SA-ALC/SFTT	1014 Billy Mitchell Blvd. Ste 1 Kelly AFB TX 78241	210-925-7613	210-925-9964	czachari@sadis05.kelly.af.mil
113	Zatezalo	Alvin	911 (758AS/MA)	316 Defense Ave Ste 101 Corapolis PA 15108-4403	412-474-8191		
114	Zerlang	Torben	Thomsen Products Inc.	604 Hayden Station Rd Windor CT 06095	860-688-8331		jzuk@mail.arc.nasa.gov
115	Znidarcic	Dr Dobroslav	Univ of Colorado	Boulder, CO 80309-0428	303-492-7577	303-492-7317	jzuk@mail.arc.nasa.gov
116	Zuk	Dr John	NASA AMES Research Cen	MS 237-11, Moffett Field CA 94035	415-604-6568	415-604-6996	jzuk@mail.arc.nasa.gov

Technology Crossfeed
on
Deicing/Anti-icing

Arlington, Virginia
20-21 August 1996

HQ Air Force Materiel Command Carroll Herring 513 257-6448

Scope

Investigate technologies to reduce toxicity and oxygen depletion problems associated with deicing/anti-icing aircraft and runways

Carroll Herring 513 257-6448

Objectives

- Exchange Information on Deicing/Anti-icing Technologies
- Support the development of Deicing/Anti-icing Strategies for future Operations
  - Status of Research & Development Efforts
  - PROs & CONs of various Chemicals & Technologies
- Assist Air Force activities achieve Compliance with minimal negative impacts on the mission
  - Understanding of Options for Compliance
  - Review Deicing/Anti-icing Studies & Implementation Efforts

Deicing/Anti-icing Operations

Aircraft Deicing

- Remove Snow, Ice & Frost

Runway Deicing & Anti-icing

- Remove Snow & Ice
- Prevention of ice deposits

Environmental Concerns

- Toxic chemicals entering water supplies
- Oxygen depletion killing fish & aquatic life in streams

Operational Controls & Restrictions

Legislation & Policy

- Clean Water Act, EPA, State & Local Limits
- Monitoring by large glycol users and best management practices to reduce below benchmark values
- National Pollutant Discharge Elimination System (NPDES) permits
- Air Force bases must apply for permits limiting chemicals in storm water runoff
- Prohibition on Purchasing ethylene glycol [Ref. USAF/CE letter dated 31 March 1992]

Guidance & Instructions

Aircraft Deicing/Anti-icing

- 42C-1-2 “Deicing/Anti-icing Technical Manual”
- Tech Orders specific to Weapon Systems
  [e.g., Flight Manuals; dash-2 Ground Support Tech Orders]
- MIL-A-8243 “Military Deicing Specification”
  - Type I - Propylene Glycol
  - Type II - Ethylene Glycol
- AMS 1424 “Aircraft Deicing/Anti-icing
  - Type I - Newtonian [Propylene, Ethylene or Mixture]
- AMS 1428 “Aircraft Deicing/Anti-icing
  - Type II,III & IV -Pseudo-Plastic Non-Newtonian
    [Propylene, Ethylene or Mixture]

Runway/taxiway Deicing

- AF Instruction 32-1045 “Snow & Ice Control”
- MIL-A-83411 “Military Deicing Specification”
- AMS 1431 “Solid Deicing/Anti-icing Runway Compounds”

Deicing/Anti-icing Chemicals & Technologies

Aircraft Deicing/Anti-icing	**Runway Deicing**
Ethylene Glycol	Potassium Acetate
Propylene Glycol	Urea
Methyl Cellosolve	Glycol Mixtures
Synthetic Deicing Fluids	Sodium Acetate
Deicing truck w/air blast	Sodium Formate
Deicing Platforms	Calcium Magnesium Acetate
Deicing Pads	Isopropyl Alcohol
Radiant Heat	Runway Ice Detection Sys (RIDS)
Modified Monosaccharides	Mechanical Deicing
Capturing Technologies	**Treatment**
Vacuum Collection Vehicles	Bioremediation/ Biological Filtration
Rubberized Mats	Wet Air Oxidation

AGENDA

20 August 1996

1400 - 1405	Welcome	
1405 -1410	Administrative	ANSER
1410 - 1425	Objectives of Crossfeed Meeting	HQ AFMC/ENBE
1425 - 1450	SAE G-12 & Commercial Specifications	G-12 Fluids Committee
1450 - 1510	Status of MIL-A-8243 Specification	Navy [Pax River]
[Comparison of Military and Civil Aviation]		
1510 - 1530	Commercial vs Military Experience	317 AS/DOLT
1530 - 1545	Break	
[Survey of Deicing/Anti-icing Products & Technologies]		
1545 - 1600	"Off-the-Shelf" Technologies [AFLMA Study]	HQ AFMC/ENBE
1600 - 1620	Literature & Technology Review [ACC Study]	HSC/YAL & AL/OEBW
1620 - 1645	COTS & R&D Information [HSC Study]	Labat-Anderson Inc

AGENDA

21 August 1996

0800 - 0810	Introduction to Clean Water Act, Permits, etc	AFCEE/CCR-D
[Survey of Deicing/Anti-icing Technologies & Chemicals]		
0810 - 0840	Deicing & Anti-icing Technologies & Case Studies	NDCEE
[Research & Development Efforts]		
0840 - 0900	Basic Research (6.1)	AFOSR/NL
0900 - 0930	Development of New Anti-icing Products	WL & NASA
[Test & Evaluation of Chemicals & Technologies]		
0930 - 0945	Toxicity Testing of new Products	OL AL HSC/OETB
0945 - 1000	Break	
1000 - 1015	Evaluation of Runway Products & Technologies	AFCESA
1015 - 1025	Na Acetate Testing at Elmendorf	3CE/CEORH
1025 - 1035	Na Formate Testing at Minot	5CES/CEO
[Military Implemnetation Efforts & Success Stories]		
1035 - 1100	Aircraft Deicing using Efficient Trucks w/Hot Air	Navy [Lakehurst]
1100 - 1125	Aircraft Deicing by Reserves at Niagara Falls	Reserves [Niagara Falls]
1125 - 1140	Small Gylcol Capturing & Disposal Operation	Reserves [Pittsburgh]
1140 - 1200	Glycol Capture & Treatment via Holding Pond	Guard [Milwaukee]

HQ Air Force Materiel Command Carroll Herring 513 257-6448

AGENDA

21 August 1996

"Industry Half Day"

[Aircraft Deicing Chemicals & Technologies]		
1300 - 1330	**Deicing Equipment & Technologies**	**Simon Aviation**
1330 - 1400	**Deicing Truck Technology Improvements**	**Landoll & FMC**
1400 - 1430	**Radiant Heat**	**Process Technologies**
[Runway Deicing & Anti-icing Chemicals & Technologies]		
1430 - 1500	**Efficient Pre-moist Chemical Spreaders**	**Thomsen Products/EPOKE**
1500 - 1515	**Break**	
[Capturing & Recycling Technologies]		
1515 - 1545	**Portable Glycol Capture Systems**	**Int'l Automated Systems**
1545 - 1615	**Pressurized Water, Vaccum & Clean-up Service**	**Costal Fluid Technologies**
1615 - 1645	**Glycol Recovery Vehicles**	**Vactor Mfg Inc**
[Treatment Products & Technologies]		
1645 - 1715	**Anaerobic Biofiltration**	**BioFiltration Systems**

HQ Air Force Materiel Command

Carroll Herring 513 257-6448

SUMMARY

- Crossfeed Objectives
  - ⇨ Review of Potential Deicing/Anti-icing Technologies
  - ⇨ Support AF Strategy development by Working Group
  - ⇨ Assist AF Activities achieve Compliance
- Appreciation to Host, Speakers & Participants
- Distribution of Crossfeed Meeting Minutes
- Future Deicing Technology Conferences
  - ⇨ Jun 97 - Deicing Session at the Air & Waste Mgt Conference
  - ⇨ Aug 97 - Aircraft & Airfield Deicing Conference & Exposition
- Meeting of AF Deicing/Anti-icing Working Group

Commercial Specs

Briefed by
Jane Hinkle
Octagon Process Inc

Secretary,
SAE G-12 Fluids Committee

BENEFITS OF USING COMMERCIAL TYPE I AND TYPE II FLUIDS

SAFETY
LONGER SUBSTANTIATED HOLDOVERS
PROVEN AERODYNAMIC CAPABILITIES

GLOBAL STANDARDIZATION
SAE STANDARDS EQUAL TO ISO
USED IN EUROPE / ASIA / NORTH AMERICA

UNIVERSAL APPLICATION METHODS
DEFINITIVE TECHNIQUES
EXACT COMMUNICATION REQUIREMENTS
STANDARDIZED EQUIPMENT

FLUID AVAILABILITY
SAME PRODUCTS AVAILABLE WORLD WIDE
MILITARY / COMMERCIAL SUPPLIES INTERCHANGEABLE

INTERNATIONAL FORUM
EXPERT ADVICE AVAILABLE
PROBLEM SOLVING RESOLUTIONS

PRACTICAL RESULTS OF G-12 EFFORTS

TRAINING

SPECS	WORKING TOPICS
DEICING FLUID APPLICATION DRAWINGS	SAMPLING
	COMMUNICATION

PRACTICAL RESULTS OF G-12 EFFORTS

METHODS

SPECS	WORKING TOPICS
ARP 4737 - METHODS OF APPLICATION	TRAINING / HOLDOVER CONSTANTLY FEEDS DATA TO BE INCORPORATED
	QUALITY ASSURANCE SECTION
	SPRAYING TECHNIQUES
	COMMUNICATION

PRACTICAL RESULTS OF G-12 EFFORTS

ICE DETECTION

SPECS	WORKING TOPICS
AS 5116 ICE DETECTOR STDS	REVIEW AND FINALIZE
	THICKNESS TESTING OF DEICERS

PRACTICAL RESULTS OF G-12 EFFORTS

HOLDOVER

SPECS	WORKING TOPICS
HOLDOVER TABLES TYPE I, TYPE II, AND TYPE IV	SUBSTANTIATE AND FINE TUNE LABORATORY / FIELD RESULTS

PRACTICAL RESULTS OF G-12 EFFORTS

FLUIDS

SPECS	WORKING TOPICS
AMS 1424 TYPE I FLUIDS, AIRCRAFT	FLAME INHIBITION
AMS 1428 TYPE II, III, IV FLUIDS, AIRCRAFT	HOT CORROSION
AMS 1431 POWDER RUNWAY DEICERS	FLUID ELIMINATION
AMS 1435 LIQUID RUNWAY DEICERS	FLUID DRY OUT
	FOAM TEST
	LABORATORY / FIELD CONFORMANCE TESTS
	RUNWAY HOLDOVER TESTS

PRACTICAL RESULTS OF G-12 EFFORTS

FACILITIES

SPECS

ARP 4902 - 5 CHAPTERS
REMOTE AND CENTRAL DEICING PAD CRITERIA

WORKING TOPICS

MARKING / LIGHTING STDS / PADS

ENGINES RUNNING / SHUT DOWN

COMMUNICATION

PRACTICAL RESULTS OF G-12 EFFORTS

EQUIPMENT

SPECS		WORKING TOPICS
ARP 1971	LARGE EQUIPMENT	SAFETY ON BOOMS
ARP 4047	SMALL EQUIPMENT	CEN / ANSI / SAE CONSOLIDATION
ARP 5058	CLOSED CAB CRITERIA	STATIONARY DEICING EQUIPMENT
CANCEL ARD 50025		DEICING PICK-UP EQUIPMENT
		RUNWAY DEICING EQUIPMENT

GOVERNMENT / COMMERCIAL COMPARISONS

	HOLDOVER TIMES (WSET)	HIGH HUMIDITY TIMES (HHET)	AERODYNAMIC ACCEPTANCE
MIL-A-8243D AM1 TYPE I, II	LESS THAN 1 MIN	LESS THAN 5 MIN	PASSES UP TO 70/30 DILUTION
AMS 1424 / ISO 11075 TYPE I	MINIMUM 3 MIN	MINIMUM 2 HOURS	PASSES UP TO 70/30 DILUTION
AMS 1428 / ISO 11078 TYPE II	MINIMUM 30 MIN	MINIMUM 4 HOURS	PASSES IN CONCENTRATE
AMS 1428 / ISO 11078 *TYPE III	-	-	-
AMS 1428 / ISO 11078 TYPE IV	MINIMUM 80 MIN	MINIMUM 8 HOURS	PASSES IN CONCENTRATE

*NOT CURRENTLY BEING PRODUCED

RUNWAY SPECIFICATIONS

SAE	TYPE	BASE	OCTAGON NAME
AMS 1431	POWDER	SODIUM ACETATE	RD 1431SA
AMS 1431	POWDER	SODIUM FORMATE	RD 1431SF
AMS 1435	LIQUID	POTASSIUM ACETATE	RD 1435
AMS 1435	LIQUID	PROPYLENE GLYCOL	RD 1426

CURRENT COMMERCIAL SPECIFICATIONS

	SAE 1424 / ISO 11075	SAE 1428 / ISO 11078
BASE MATERIAL / FORMULA	TYPE I - OPTIONAL	TYPE II, III*, IV - OPTIONAL
FORM	WATER THIN LIQUID	GEL TYPE LIQUID
NORMAL USAGE	HEATED / DILUTED	COLD / CONCENTRATED
FUNCTION	AIRCRAFT WING DEICER	AIRCRAFT WING ANTI-FREEZE
AVAILABILITY	DRUMS / BULK	DRUMS / BULK
BIODEGRADABILITY	BIODEGRADABILITY / TRACE METALS REQUIRED	BIODEGRADABILITY / TRACE METALS REQUIRED
LOT ACCEPTANCE	4-6 HOURS TESTING	4-6 HOURS TESTING
CORROSION TESTING	ASTM F 1110, ASTM F 483 ASTM F 1111, ASTM F 945 ASTM F 519 REQUIRED	ASTM F 1110, ASTM F 483 ASTM F 1111, ASTM F 945 ASTM F 519 REQUIRED

*NOT CURRENTLY BEING SOLD OR MANUFACTURED

SAE G-12

MEMBERSHIP GROUPS

AAAE
AEA
ALPA
ASTM
ATA
EPA
FAA
IATA
ICAO
ISO
NASA
TC
USAF

AIRLINES
AIRPORTS
CONSULTANTS
EQUIPMENT VENDORS
FLUID VENDORS
OEM'S

SAE G-12

PARTICIPATING AIRLINES

AIR CANADA

AMERICAN AIRLINES

CANADIAN AIRLINES

CONTINENTAL AIRLINES

DELTA AIR LINES

FEDERAL EXPRESS

NORTHWEST AIRLINES

TWA

UNITED AIRLINES

UPS

USAIR

AIR FRANCE

ALL NIPPON AIRWAYS

AUSTRALIAN AIRLINES

BRITISH AIRWAYS

FINNAIR

JAPAN AIRLINES

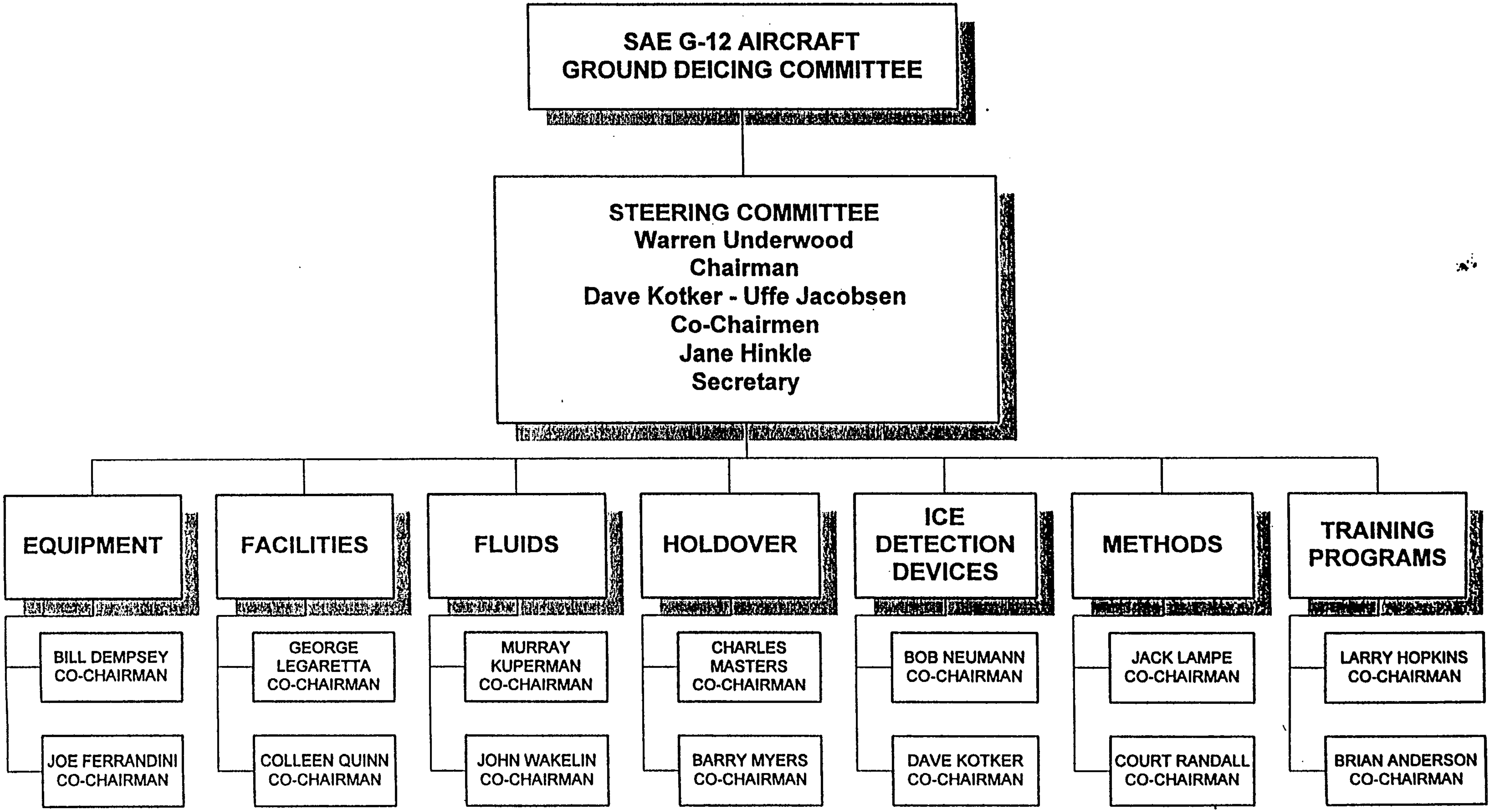
KLM

LUFTHANSA

SAS

SWISSAIR

05



SAE G-12 AIRCRAFT GROUND DEICING COMMITTEE
STEERING COMMITTEE
Warren Underwood
Chairman
Dave Kotker - Uffe Jacobsen
Co-Chairmen
Jane Hinkle
Secretary
EQUIPMENT
BILL DEMPSEY CO-CHAIRMAN
JOE FERRANDINI CO-CHAIRMAN
FACILITIES
GEORGE LEGARETTA CO-CHAIRMAN
COLLEEN QUINN CO-CHAIRMAN
FLUIDS
MURRAY KUPERMAN CO-CHAIRMAN
JOHN WAKELIN CO-CHAIRMAN
HOLDOVER
CHARLES MASTERS CO-CHAIRMAN
BARRY MYERS CO-CHAIRMAN
ICE DETECTION DEVICES
BOB NEUMANN CO-CHAIRMAN
DAVE KOTKER CO-CHAIRMAN
METHODS
JACK LAMPE CO-CHAIRMAN
COURT RANDALL CO-CHAIRMAN
TRAINING PROGRAMS
LARRY HOPKINS CO-CHAIRMAN
BRIAN ANDERSON CO-CHAIRMAN

CURRENT GOVERNMENT SPECIFICATION

MIL-A-8243D AMENDMENT 1

	TYPE I	TYPE II
BASE MATERIAL / FORMULA	PROPYLENE GLYCOL (AS STATED)	ETHYLENE GLYCOL (AS STATED)
FORM	WATER THIN LIQUID	WATER THIN LIQUID
NORMAL USAGE	HEATED / DILUTED	HEATED / DILUTED
FUNCTION	AIRCRAFT WING DEICER	AIRCRAFT WING DEICER
AVAILABILITY	DRUMS / BULK	DRUMS / BULK
BIODEGRADABILITY	NO REQUIREMENTS	NO REQUIREMENTS
LOT ACCEPTANCE	3 DAYS REQUIRED	3 DAYS REQUIRED
CORROSION TESTING	LIMITED	LIMITED

DIRECTORATE OF RESEARCH
[redacted]
WRIGHT-PATTERSON AIR FORCE BASE
[redacted] OHIO

NOV 19 1952

MATERIALS LABORATORY
TEST REPORT ON

FLUID: DE-ICING AND DEFROSTING, SPECIFICATION NUMBER 3609, QUALIFICATION TEST OF, OCTAGON PROCESS INC, FORMULA-900

Report No. WCRT H52-318 | Date 4 November 1952

Project No. S611-18 | Spec. No.

Contractor | Contract No.

Submitted by | P. O. No.

I PURPOSE

To test a sample of de-icing and de-frosting fluid for conformance with the requirements of Specification Number 3609.

II FACTUAL DATA

Two, one gallon samples of de-icing and de-frosting fluid, octagon-900, manufactured by Octagon Process Inc., and submitted with letter dated 5 Sept. 1952, were subjected to tests for conformance with the requirements of Specification No. 3609. Results of tests are given in Appendix 1.

III CONCLUSIONS

Results of tests indicated that subject materials conformed to all requirements of Specification Number 3609.

IV RECOMMENDATION

The Materials Laboratory, Directorate of Research, WADC, will take action to place subject materials on the applicable QPL as an approved product.

COORDINATION:

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PUBLICATION REVIEW

This report has been reviewed and is approved

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Appendix 1

Results Of Specification 3609 Tests

TESTS	RESULTS
Appearance	Satisfactory
Consistency and Flow	Satisfactory
Toxicity	Satisfactory
Corrosion	
Steel	Satisfactory
Alloy	Satisfactory
Alclad	Satisfactory
Brass	Satisfactory
Copper	Satisfactory
Slush Point	
Package material	Satisfactory 57°F.
Package Materials plus 50% H_2O	Satisfactory 80°F.
Amount of Dilution to 20°	
Control	Satisfactory 120%
Sample	Satisfactory 140%
Acrylic Base Plastic	Satisfactory
Doped Fabric Finishes	Satisfactory
Painted Surfaces	Satisfactory
Rubber De-Icer Shoe	Satisfactory
Flash Point	Satisfactory 89°F
Service Test	Not Required

MIL-D-8243 (USAF)
26 March 1953

SUPERSEDING
AF 3609
23 April 1947

MILITARY SPECIFICATION

DE-ICING AND DE-FROSTING FLUID

1. SCOPE

1.1 This specification covers one type of de-icing and de-frosting fluid.

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS AND PUBLICATIONS

2.1 The following specifications and standards of the issue in effect on date of invitation for bids, form a part of this specification.

SPECIFICATIONS

FEDERAL:

L-P-406	Plastics, Organic; General Specifications, Test Methods
NN-B-601	Boxes, Wood-Cleated-Plywood, For Domestic Shipment
NN-B-621	Boxes, Wood, Nailed and Lock-Corner
QQ-A-355	Aluminum-Alloy (24S)-Plate and Sheet
QQ-A-362	Aluminum-Alloy (Clad 24S); Plate and Sheet
QQ-B-611	Brass; Commercial, Bars, Plates, Rods, Shapes, Sheets and Strips
QQ-C-576	Copper Plates, Sawed Bars, Sheets, and Strips
TT-A-468	Aluminum-Pigment; Powder and Paste for Paint
TT-N-95	Naptha, Petroleum, Aliphatic (For use in organic coatings)
TT-P-141	Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing
TT-T-266	Thinner; Dope and Lacquer (Cellulose Nitrate)

Carpenter Litho & Prtg. Co., Springfield, Ohio 6-53-1000

SAE TYPE I FLUID

TABLE 2 - Guideline for Holdover Times Anticipated for SAE Type I Fluid Mixture as a Function of Weather Conditions and OAT

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER AND SHOULD ONLY BE USED IN CONJUNCTION WITH THE SAE METHODS DOCUMENT (SEE CAUTIONS)

OAT		Approximate Holdover Times Under Various Weather Conditions (hours: minutes)					
°C	°F	*FROST	FREEZING FOG	SNOW	**FREEZING DRIZZLE	LIGHT FREEZING RAIN	RAIN ON COLD SOAKED WING
above 0	above 32	0:45	0:12-0:30	0:06-0:15	0:05-0:08	0:02-0:05	0:02-0:05
0 to -10	32 to 14	0:45	0:06-0:15	0:06-0:15	0:05-0:08	0:02-0:05	
below -10	below 14	0:45	0:06-0:15	0:06-0:15			

°C = Degrees Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
FP = Freezing Point

*During conditions that apply to aircraft protection for ACTIVE FROST.
**Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.

SAE Type I Fluid/Water Mixture is selected so that the FP of the mixture is at least 10°C(18°F) below OAT.

CAUTION: THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS. HEAVY PRECIPITATION RATES OR HIGH MOISTURE CONTENT, HIGH WIND VELOCITY OR JET BLAST MAY REDUCE HOLDOVER TIME BELOW THE LOWEST TIME STATED IN THE RANGE. HOLDOVER TIME MAY BE REDUCED WHEN AIRCRAFT SKIN TEMPERATURE IS LOWER THAN OAT. THEREFORE, THE INDICATED TIMES SHOULD BE USED ONLY IN CONJUNCTION WITH A PRE-TAKEOFF CHECK.

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5/23/96

SAE TYPE II FLUID

TABLE 4 - Guideline for Holdover Times Anticipated for SAE Type II Fluid Mixtures as a Function of Weather Conditions and OAT

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER AND SHOULD ONLY BE USED IN CONJUNCTION WITH SAE METHODS DOCUMENT. (SEE CAUTIONS)

OAT		SAE Type II Fluid Concentration Neat-Fluid/Water (Vol %/Vol %)	Approximate Holdover Times Under Various Weather Conditions (hours:minutes)					
°C	°F		*Frost	Freezing Fog	Snow	***Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
above 0	above 32	100/0	12:00	1:15-3:00	0:20-1:00	0:30-1:00	0:15-0:30	0:20-0:40
		75/25	6:00	0:50-2:00	0:15-0:45	0:20-0:45	0:10-0:25	0:10-0:25
		50/50	4:00	0:35-1:30	0:05-0:15	0:15-0:25	0:05-0:15	
0 to -3	32 to 27	100/0	8:00	0:35-1:30	0:20-0:45	0:30-1:00	0:15-0:30	
		75/25	5:00	0:25-1:00	0:15-0:30	0:20-0:45	0:10-0:25	
		50/50	3:00	0:15-0:45	0:05-0:15	0:15-0:25	0:05-0:15	
below -3 to -14	below 27 to 7	100/0	8:00	0:35-1:30	0:20-0:45	**0:30-1:00	**0:10-0:30	
		75/25	5:00	0:25-1:00	0:15-0:30	**0:20-0:45	**0:10-0:25	
below -14 to -25	below 7 to -13	100/0	8:00	0:35-1:30	0:20-0:45			
below -25	below-13	100/0	SAE TYPE II fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of SAE Type I where SAE Type II fluid cannot be used.					

°C = Celsius
°F = Degrees Fahrenheit
OAT = Outside Air Temperature
Vol = Volume

*During conditions that apply to aircraft protection for ACTIVE FROST.
**The lowest use temperature is limited to -10°C (14°F).
***Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.

CAUTION: THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS. HEAVY PRECIPITATION RATES OR HIGH MOISTURE CONTENT, HIGH WIND VELOCITY OR JET BLAST MAY REDUCE HOLDOVER TIME BELOW THE LOWEST TIME STATED IN THE RANGE. HOLDOVER TIME MAY BE REDUCED WHEN AIRCRAFT SKIN TEMPERATURE IS LOWER THAN OAT. THEREFORE, THE INDICATED TIMES SHOULD BE USED ONLY IN CONJUNCTION WITH A PRE-TAKEOFF CHECK.

5/23/96

SAE TYPE IV FLUID

TABLE 5 - Guideline for Holdover Times Anticipated for SAE Type IV Fluid Mixtures as a Function of Weather Conditions and OAT

THE RESPONSIBILITY FOR THE APPLICATION OF THESE DATA REMAINS WITH THE USER AND SHOULD ONLY BE USED IN CONJUNCTION WITH SAE METHODS DOCUMENT. (SEE CAUTIONS)

OAT		SAE Type IV Fluid Concentration	Approximate Holdover Times under Various Weather Conditions (hours:minutes)					
°C	°F	Neat-Fluid/Water (Vol %/Vol %)	*Frost	Freezing Fog	Snow	***Freezing Drizzle	Light Freezing Rain	Rain on Cold Soaked Wing
above 0	above 32	100/0	18:00	2:00-3:00	0:55-1:40	0:45-1:50	0:30-1:00	0:20-0:40
		75/25	6:00	0:40-2:00	0:20-1:00	0:20-1:00	0:15-0:30	0:10-0:25
		50/50	4:00	0:15-0:45	0:05-0:25	0:07-0:15	0:05-0:10	
0 to -3	32 to 27	100/0	12:00	2:00-3:00	0:45-1:40	0:45-1:50	0:30-1:00	
		75/25	5:00	0:40-2:00	0:15-1:00	0:20-1:00	0:15-0:30	
		50/50	3:00	0:15-0:45	0:05-0:20	0:07-0:15	0:05-0:10	
below -3 to -14	below 27 to 7	100/0	12:00	2:00-3:00	0:35-1:15	**0:45-1:50	**0:30-0:55	
		75/25	5:00	0:40-2:00	0:15-1:00	**0:20-1:00	**0:10-0:25	
below -14 to -25	below 7 to -13	100/0	12:00	1:00-2:00	0:30-1:10			
below -25	below -13	100/0	SAE TYPE IV fluid may be used below -25°C (-13°F) provided the freezing point of the fluid is at least 7°C (13°F) below the OAT and the aerodynamic acceptance criteria are met. Consider use of SAE Type I where SAE Type IV fluid cannot be used.					

°C Celsius
°F Degrees Fahrenheit
OAT Outside Air Temperature
Vol Volume

*During conditions that apply to aircraft protection for ACTIVE FROST.
**The lowest use temperature is limited to -10°C (14°F).
***Use light freezing rain holdover times if positive identification of freezing drizzle is not possible.

CAUTION: THE TIME OF PROTECTION WILL BE SHORTENED IN HEAVY WEATHER CONDITIONS. HEAVY PRECIPITATION RATES OR HIGH MOISTURE CONTENT, HIGH WIND VELOCITY OR JET BLAST MAY REDUCE HOLDOVER TIME BELOW THE LOWEST TIME STATED IN THE RANGE. HOLDOVER TIME MAY BE REDUCED WHEN AIRCRAFT SKIN TEMPERATURE IS LOWER THAN OAT. THEREFORE, THE INDICATED TIMES SHOULD BE USED <u>ONLY IN CONJUNCTION WITH A PRE-TAKEOFF CHECK</u>.

5/23/96

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Military Specification Wing Deicer

Phil Bevilacqua
Naval Air Warfare Center
Patuxent River, MD

Advantages of Mil-A-8243

- Able to specify base material:
  - Type I - Propylene Glycol, more environmentally acceptable
  - Type II - Ethylene Glycol
- Materials from different manufacturers are compatible

Disadvantages of Mil-A-8243

- Low/no holdover time
- Includes non-standard corrosion test based on visual appearance only
- Not a performance specification; no opportunity for improvement

Barriers to adopting AMS 1424 (Newtonian liquid type)

- No provision for specifying base material
- Materials from different manufacturers may not be compatible or may require different equipment
- Maximum allowable weight loss in corrosion test is an order of magnitude too high for Navy use

Corrosion Limits
mg/cm2/day

Material	NAVAIR	AMS 1424
Aluminum	0.04	0.3
Steel	0.04	0.8
Titanium	0.04	0.1
Magnesium	0.2	0.2
Cadmium	0.2	0.3

Alternatives

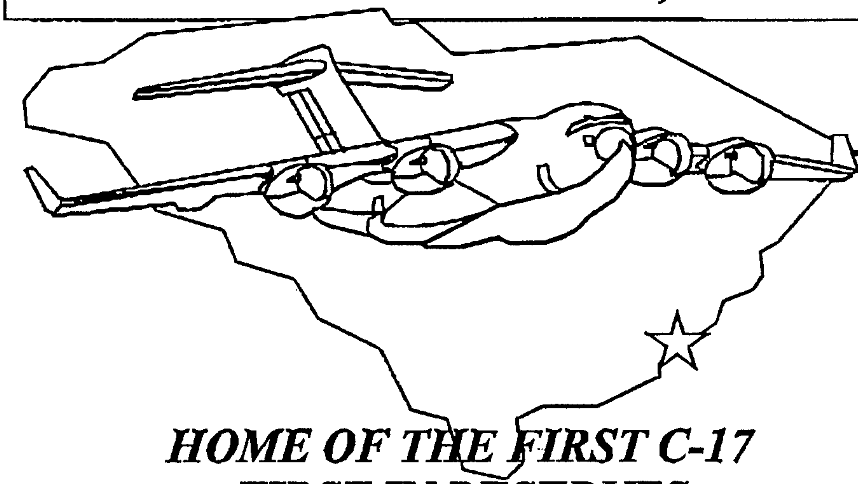
- Revise AMS 1424 to address base material, equipment compatibility, and corrosion concerns
- Change Mil-A-8243 to a performance specification similar to AMS 1424

Military Specification Wing Deicer

Phil Bevilacqua
Naval Air Warfare Center
Patuxent River, MD

The Navy currently uses Mil-A-8243 for aircraft wing deicing. Type I, propylene glycol based fluid, is become the standard since it is preferred from an environmental standpoint over Type II, ethylene glycol based fluid. The primary drawback in using Mil-A-8243 is a very short holdover time. The Navy is reluctant to adopt the Society of Automotive Engineers deicing specification AMS 1424, however, since this spec does not allow the base material to be specified, does not have strict corrosion requirements, and may cause procurement problems due to incompatible formulations from different manufacturers.

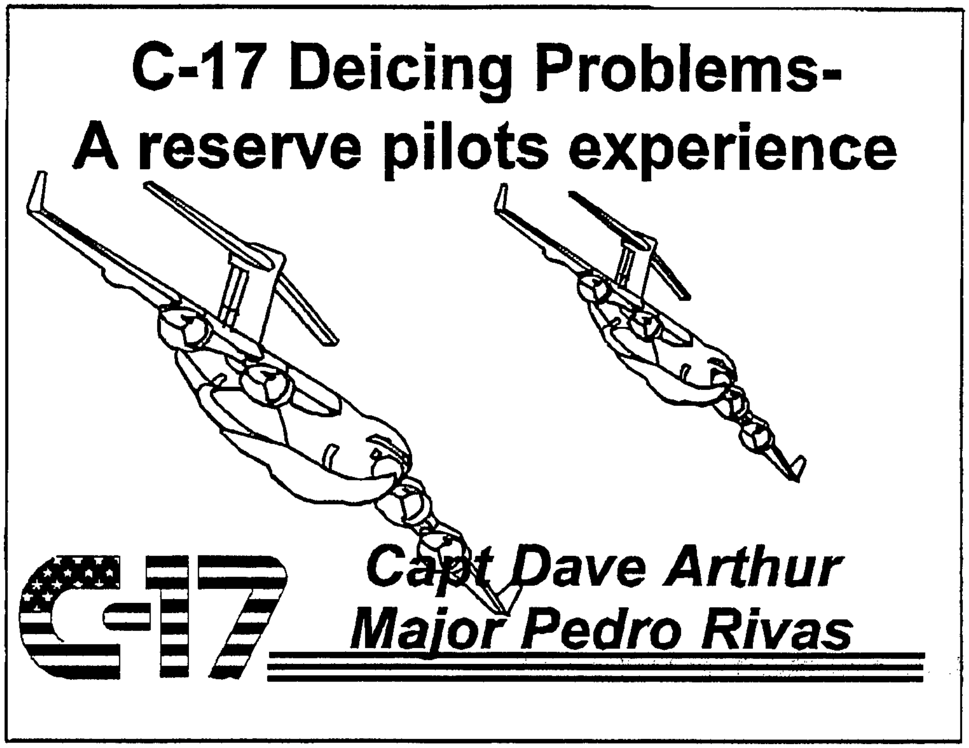
GREETINGS FROM THE 317 AS
CHARLESTON AFB, SC



HOME OF THE FIRST C-17
FIRST IN RESERVES

Intro-

*A perspective from C-17 USAF Reserve/American Airlines pilot

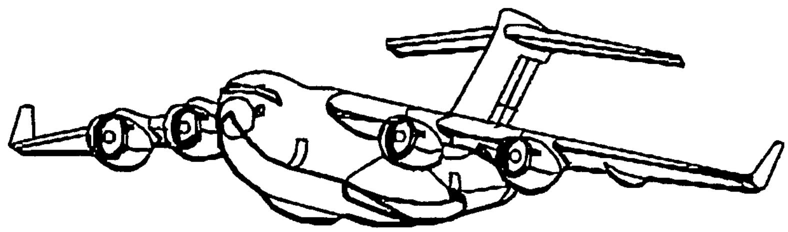


*Problems with C-17 and military (in general) deicing and anti-icing procedures and fluids

*Large disparity between military and commercial training, technology, and procedures

*My four years commercial airline experience eluded to disparity

Deicing/Anti-icing Fluids



- **Outdated Winter Operational Procedures**
- **Military Fluid Labeling**
- **Adoption of :**
  - **SAE 1424 - Type I (Mar 95)**
  - **SAE 1428 - Type II (Jun 96)**

*Military using outdated fluids and procedures

*Includes non-standardized technical orders

*C-17 newest aircraft in airlift inventory

*C-17 capabilities--direct delivery mission

*A winter storm can nearly stop C-17 operations

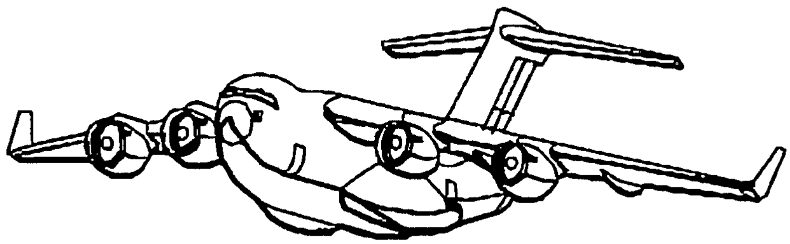
*Military labeling deicing fluids Type I and Type II conflicts with commercial labeling

*Dangerous misleading were military Type II is not the same as commercial Type II, reserve pilots with airline experience may be mislead that military Type II has same properties as commercial Type II

*Aircrews welcome the adoption of both SAE 1424 and 1428

*Step in the right direction

C-17 Deicing/Anti-icing Problems



• **Initial C-17 Procedures**

*Three fundamental problems preventing increased utility in winter weather

-required use of non-standard equipment

-current limited effectiveness of military fluids

-outdated, non-standardized procedures and training

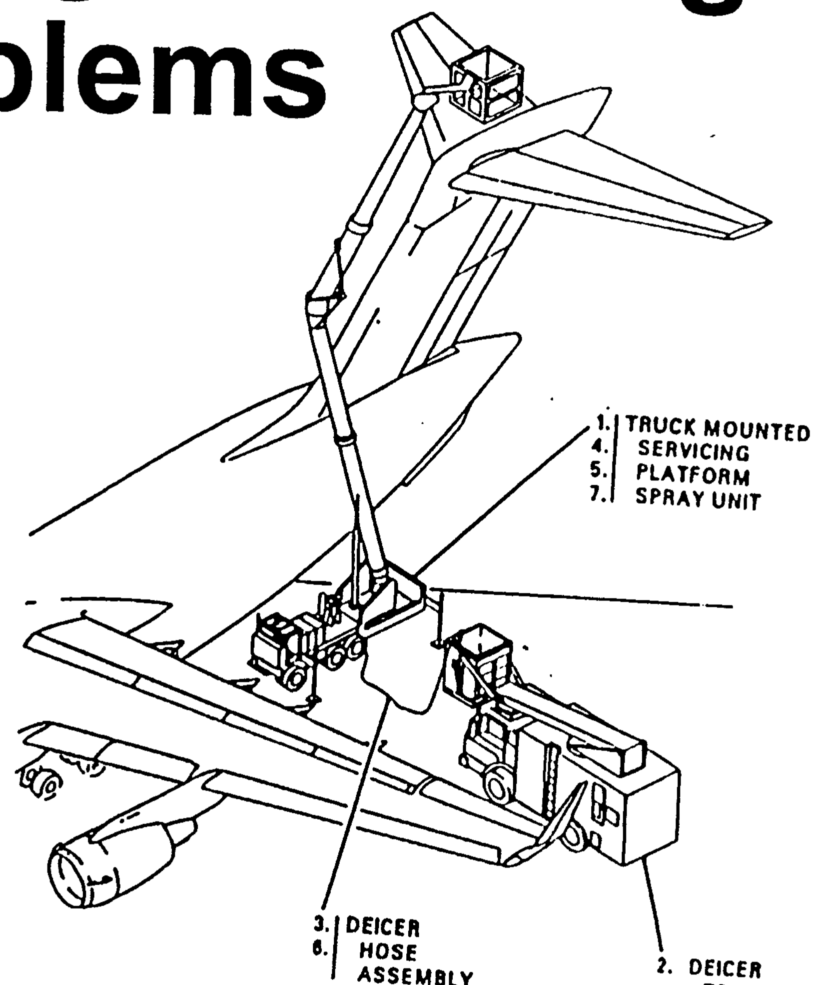
*Initial C-17 procedures developed by aircrew members with large military aircraft backgrounds--using past aircraft procedures

*Outdated procedure quote from original C-17 manual "Takeoff must be made within thirty minutes after application of deicing fluid"

*No reference to start timing or what fluid applicable for

*I have authored changes to C-17 procedures adopting commercial procedures, holdover time tables, and commercial fluid information

C-17 Deicing/Anti-icing Problems



- T-tail Height
  - –Special truck - Calavar Condor

C-17 Deicing/Anti-icing Problems

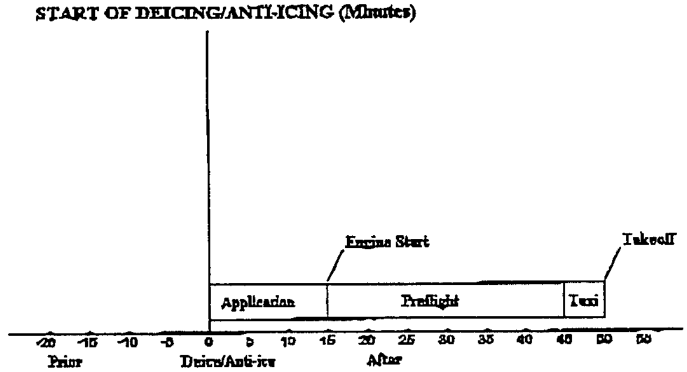
- T-tail Height
  - –Special truck - Calavar Condor

*How long does it take to de-ice a C-17?

*Factor with deicing/anti-icing t-tail like the C-5

*Special equipment–Calavar Condor

-basically a platform truck that provides a long enough extension to the deicing truck's hose



*How long does it take the C-17 to complete deicing, start engines, and complete systems preflight?

*Estimated takes 15 minutes with adequate equipment

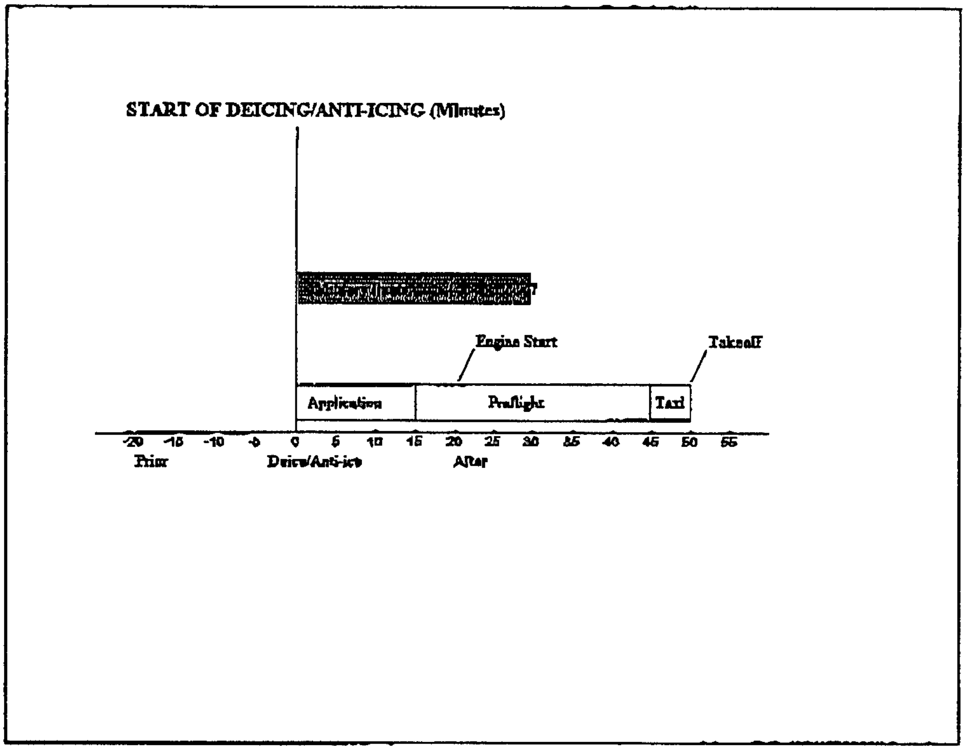
*The start of the final application starts the holdover time

*Preflight to taxi can take up to 40 minutes with full fly-by-wire preflight

*Can be reduced to around to 30 minutes without full preflight

*Now were about 45 minutes into our holdover time

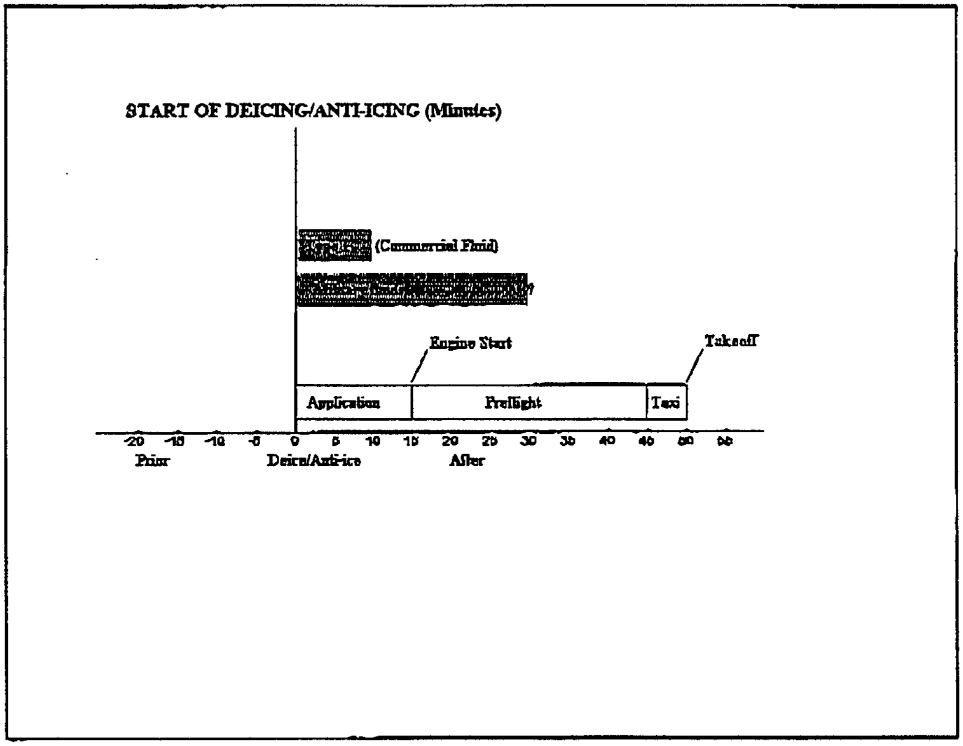
*Assume 5 minute taxi time but could be much longer at joint use or civilian airfields



*Now compare military fluids

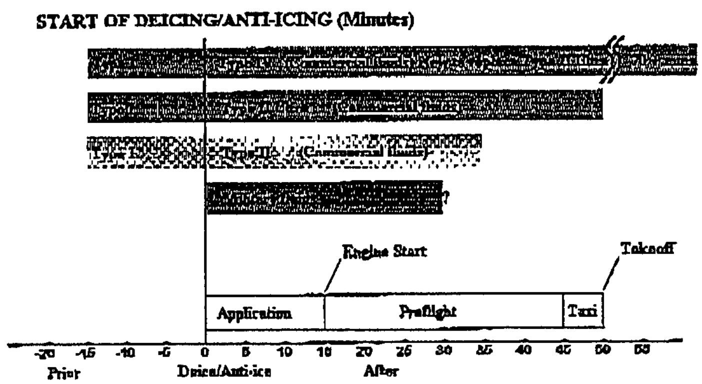
*Question mark indicates unknown holdover time

*Assume storm scenario with consistent moderate snowfall rates, OAT at 25°F, and maximum equipment availability



*Actual data from vendors show military fluids have minimal holdover times compared to commercial Type I

*Commercial Type I is really a deicer not an anti-icer

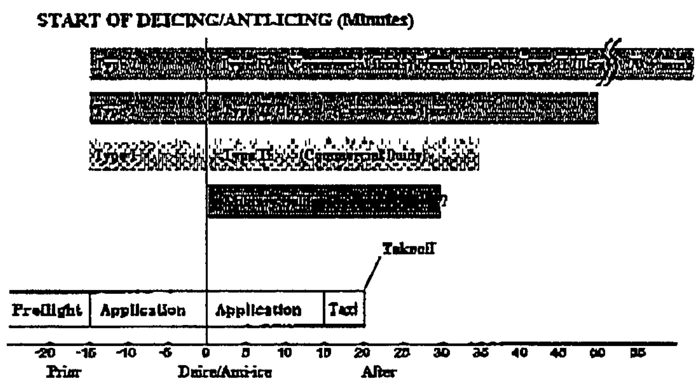


*Commercial Type II has good holdover times but will not help the C-17

*Commercial Type II Ultra may work in this scenario

*Times are from 1995-96 approved holdover time tables

*The new commercial Type IV show great potential for the C-17



*Current alternatives for the C-17 are an engine running deicing and anti-icing

*Concerns about safety and an engine running de-ice operation

*Another alternative like the engine running de-ice operation is a threshold deice operation

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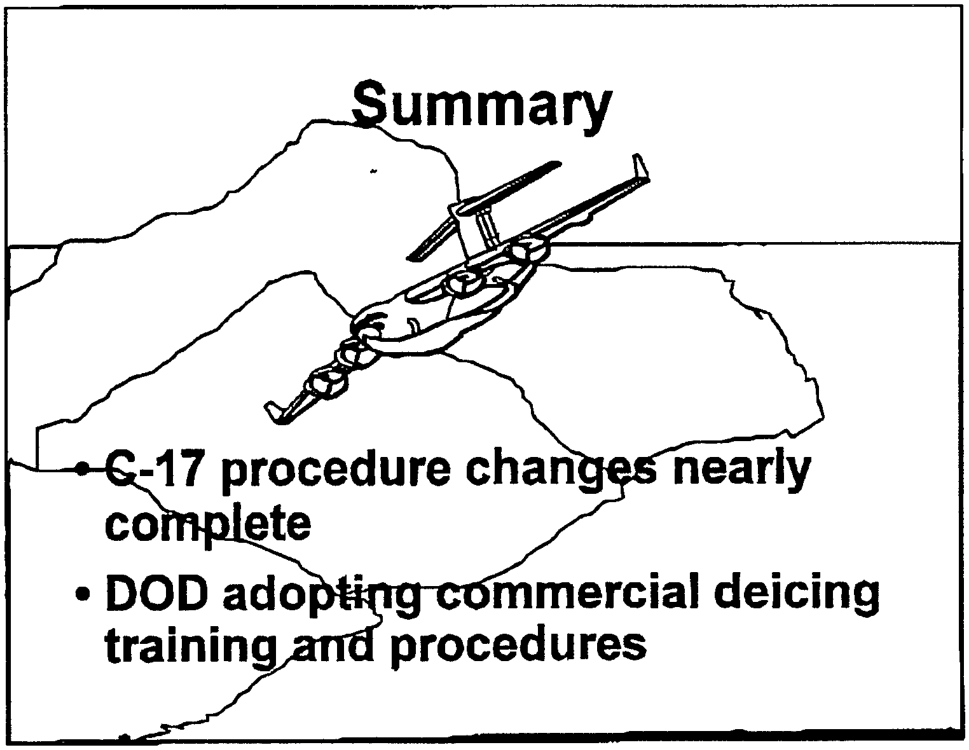
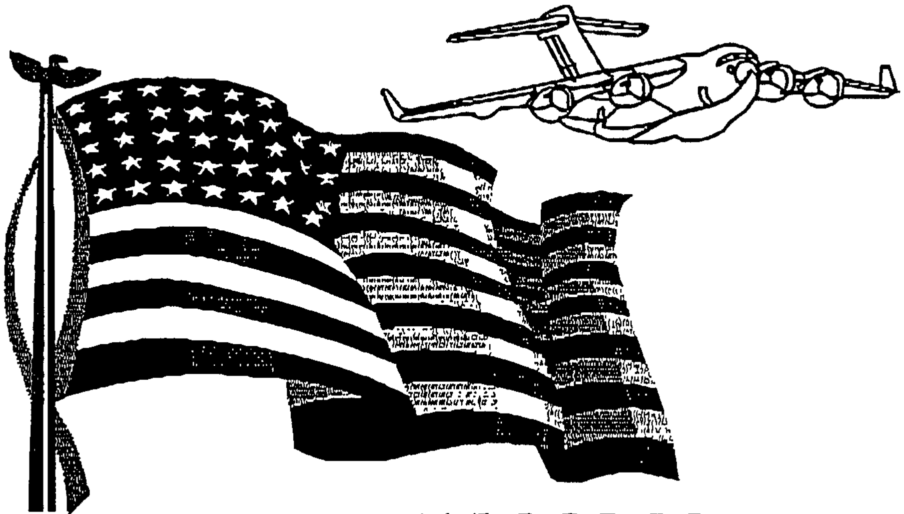


*DOD down to each Air Force major command must create a common deicing/anti-icing procedure for all aircraft as well as standardized training programs for ground deicing crews and aircrews

*Update by adoption to commercial industry standards

*Identify weapon systems that require specialized equipment and procedures

*Immediately change military labeling to prevent confusion with commercial Type II



THANK YOU

*C-17 is a very capable aircraft, give us the tools to significantly improve our safety and flexibility in winter weather

*Thank you for this opportunity to speak to you

❶ Good afternoon. I'm Captain Dave Arthur and assisting me is Major Pedro Rivas. We are reserve C-17 pilots based with the 315th Airlift Wing, 317th Airlift Squadron, Charleston AFB, South Carolina. Both of us are also commercial airline pilots. ❷ The purpose of this briefing is to give you a pilots perspective of where we see problems with not only C-17 winter deicing/anti-icing operations but military winter deicing/anti-icing operations as well.

My four years experience at a major airline have allowed me to witness a great disparity between military and commercial aviation deicing/anti-icing technology, training, and procedures ❸. Military aircraft, over the past decade, have been operating with outdated winter operational procedures and resources. This also includes non-standardized aircraft technical orders. It seems that every aircraft has a different way to conduct deicing operations.

The C-17 is the latest addition to the military's airlift fleet. The aircraft's hallmark is the direct-delivery of outsized cargo over global distances into short, austere airfields. But, this unsurpassed capability can be halted by a simple winter storm. This briefing will introduce you to three fundamental problems with current military and C-17 deicing operations.

Military deicing/anti-icing fluids are limited in their scope compared to today's commercial deicing/anti-icing fluids. But more importantly, fluid labeling is inconsistent with commercial fluid specifications and is <u>dangerously misleading</u>. Military Type I and Type II fluids are similar <u>only</u> to commercial Type I fluids. To prevent associating military Type II fluids with commercial Type II, a change to the military labeling is needed immediately. For example, labeling military fluids Type IA and Type IB would not lead to confusion with commercial fluids and better represent their characteristics.

On 24 March 1995, the Department of Defense adopted the use of [Society of Automotive Engineers] (SAE) 1424 Type I fluid. The ultimate users, Air Force aircrews, welcome this long overdue change. We feel it is a step in the right direction. As you will see shortly, this adoption will not solve all the C-17's deicing requirements. We must acquire the commercial aviation industry standards and training so that our commanders can have greater flexibility.

There are three fundamental problem areas for the C-17 and most other airlift aircraft. These problems affect safe winter operations and prevent the increased utility and departure reliability of these airlift assets. They are: required use of non-standard equipment, current limited effectiveness of military deicing/anti-icing fluids, and the use of outdated, non-standardized training and procedures ❹.

The first problem is with outdated or non-standardized procedures. The initial cadre of C-17 aircrew publication managers had backgrounds in heavy airlift aircraft. Many of the initial C-17 technical orders, procedures, and regulations were adopted from these older aircraft publications and procedures. Until specific C-17 aircraft and mission capabilities came to fruition, portions of these publications remained unchanged. Specifically, the cold weather operations section of the aircraft flight manual.

Let me expound on a quotation from the original C-17 pilot flight manual, cold weather operations section. Quote, **Takeoff must be made within thirty minutes after application of deicing fluid**, unquote. It does not tell you when to begin the 30 minutes or what type of fluid the time is good for. This procedure's exact origin is not known, but has been in use with Air Force airlift aircraft well over fifteen years. Until this year, it was the standard by which other airlift aircrews considered it safe for takeoff after deicing.

Major Rivas and myself have since authored numerous changes to the C-17 cold weather operating procedures adopting current commercial deicing/anti-icing practices. The most recent change, which is soon to be released, will include commercial deicing/anti-icing fluid information, holdover time tables, and procedures for deicing/anti-icing with engines running.

The following C-17 winter scenario will highlight the other two problems; nonstandard equipment and use of military fluids. To better highlight these problems, let's assume a winter storm with <u>continuous moderate</u> snowfall and an outside air temperature of 25'F.

How long does it take to de-ice a C-17? ❺ A factor affecting the C-17, and the C-5 aircraft as well, is the ability for

equipment to apply deicing/anti-icing fluid to the aircraft's 't-tail,' i.e. the elevator and horizontal stabilizer. A standard aircraft deicing truck cannot reach the top of the C-17 t-tail. A special type of truck is required. This extra tall 'cherry picker', called a Calavar Condor, is basically a platform truck that provides a long enough extension to the deicing truck's hose so it can properly de-ice the aircraft's t-tail.

Next, how long does it take for the aircraft to start engines and subsequently takeoff? This brings us to our third problem. Let's assume three deicing trucks and one calavar condor is available in this winter scenario: ❻ a best case equipment scenario. The application of military Type I fluid to de-ice the C-17 should take around 15 minutes. We are now up to 15 minutes into the scenario and haven't started the aircraft engines.

The C-17 has unique preflight characteristics because of its' modern electronic flight controls--better known as fly-by-wire flight controls. It takes up to 40 minutes from the beginning of the 'Before starting engines checklist', assuming a full fly-by-wire preflight is required, to the time the aircraft is ready to taxi. If only an abbreviated preflight is required then 30 minutes between engine start and taxi. So assume best case with only a 30 minute preflight. Therefore, we are now 45 minutes since the application of deicing fluid.

Now add an additional 5 minutes for taxiing to the runway. This profile results in the C-17 taking close to one hour from the time deicing fluid application began to actual aircraft takeoff. Don't forget we assumed lots of de-ice equipment and a short preflight. ❼ Compare to military deicing fluids. Remember, no holdover time exists with military fluids. Just takeoff within 30 minutes has been the only time limit. ❽ Commercial Type I has limited anti-ice capabilities.

Now take the same scenario and apply commercial Type II and Type II Ultra fluids. ❾ Using 1995-1996 holdover tables, undiluted Type II fluid would have a holdover time of approximately 35 minutes while Type II Ultra provides a holdover time of approximately 50 minutes. Holdover time would be exceeded for Type II and we would be at the end of the holdover time for Type II Ultra. A new Type IV fluid will probably be used this year by the commercial airlines. It has great potential for long holdover times.

⑩ One work around in this constant snowfall scenario is the application of commercial Type I fluids to clean the aircraft prior to engine start, then after engine start, when the aircraft is ready to taxi, apply both commercial Type I to re-clean the aircraft and then Type II for anti-icing. This gives the maximum time and safety benefit to the aircrew. A modification to this would be a threshold deicing/anti-icing program.

The Department of Defense down to each Air Force major command must create a common deicing/anti-icing procedure for all aircraft as well as standardized training programs for ground deicing crews and aircrews ❶❶.

In summary, if we solve these three problems for the C-17 then all military aircraft could be utilized in greater numbers regardless of the winter weather while greatly improving safety margins. The Department of Defense need's these up-to-date commercial fluids and equipment. They also need to standardize all ground and aircrew winter operations training and procedures. Because military aircraft are designed for specific missions, like the C-17, they may require specialized procedures and equipment as well. ❶❷ The C-17 is a very capable aircraft. Give us the tools to significantly improve our safety and flexibility in the worst winter weather. Thank you for this opportunity to speak to you today.

De-Icing Technologies

OBJECTIVE

Review existing "off-the-shelf" technologies that will prevent the negative environmental impact of current USAF aircraft de-icing procedures

AFMC

Methodology

Study accomplished through literature searches of current publications; contacting source references and various civilian and military agencies

Civil Aviation vs Military Operations

- Air Force
  - Frozen precipitation & snow due to long periods on the ground
  - Little delay between deicing & departure
- Civil Aviation
  - Majority of service life spent in flight
  - Long delays on taxiway waiting for clearance

Technologies Actively Used in USAF/Civil Aviation

- USAF De-Icing Truck with Air-Blast System
- Coolant Recycling/Bulk Glycol Recycling
- Aircraft Anti-Icing/De-Icing Fluid Collection Service
- Automated De-Icing Platforms
- Heavy Mat Fluid Capture Systems

AFMC

Existing Technologies That Have Potential to be Adapted to De-Icing

- Automotive Coolant Recycling
- Radiant Heat
- Biological Filtration
- Landfill Liner Type Fluid Collection Systems

Automotive Coolant Recycler

- Series of filters & a vacuum distillation system
- Coolant is filtered; distilled to required specification & additives mixed in to return it to original composition
- Approved by US Army [lead service] for reclaiming vehicle coolant
- Used by Dover AFB to reclaim engine coolants
- Purchase through normal USAF supply at cost of $12,000 plus consumables for 55 gal/cycle model

Radiant Heat

- Infrared burners or natural sunlight to heat taxi-through enclosures
- FAA was testing the technology but results were not yet available
- Used on railroad ore cars in upper midwest
- Concerns:
  - Potential effect on sensitive guidance & tracking systems
  - Potential for melted precipitation to re-freeze in control surface areas

AFMC

Biological Filtration

- Aerated retention pond or an anaerobic biofilter & additives to break down fluid
- Aeration speeds up natural biodegradation process
- Anaerobic biodegradation reduces the amount of sludge & produces gases which can provide heat for operating the process during cold weather

Liner & Fluid Collection Systems

- Chemically resistant liner stretched over a flexible berm
- Requires a pumping station to transfer the fluid from the mat to a holding area
- Being used for wash water containmnet by Nat'l Aeronautic & Space Administration at El Paso, Texas

Availability of the AFLMA Report

For a copy of AFLMA Final Report LM9416500 contact:

Defense Technical Information Center (DTIC)
at 1-800-225-3842

Distribution limited to U.S. Government Agencies & their Contractors for reasons of Administrative or operational use

AFMC

ACC Deicing/Anti-icing Operations Compliance Evaluation and Requirements Identification

CAPT PAUL J. FRONAPFEL
AL/OEBW
Technical Project Manager

LT YVONNE SPENCER
HSC/YAL
Program Manager

OVERVIEW

- BACKGROUND
- REQUIREMENTS
- PROGRAM DIRECTION
- PROGRAM OBJECTIVE
- PROGRAM DESCRIPTION
- ACQUISITION STRATEGY
- PROGRAM SCHEDULE
- SUMMARY

BACKGROUND

- DEICING HAS BECOME A 'HOT' ITEM
  - AFMC/CEV BRIEFED AF DEICING/ANTI-ICING EFFORTS TO HQ AF/LG AND AF/CE
  - ACC LOST $2.7M PROJECT DUE TO LACK OF DEICING/ANTI-ICING INFO
  - WILDLIFE KILLS RESULTED FROM USING UREA FOR RUNWAY ANTI-ICING OPERATIONS

REQUIREMENTS

- **FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS**
  - Clean Water Act NPDES Requirements
  - SWPPP Non-storm Discharge Certifications
- **POLLUTION PREVENTION**
- **PROACTIVE NOV AVOIDANCE**

PROGRAM DIRECTION

- HQ ACC/CEV TASKED AL/OEBW TO EVALUATE DEICING/ANTI-ICING ISSUES

- HQ ACC/CEV REQUESTED HSC/YAL ASSISTANCE

- PARTICIPANTS: AL/OEBW (LEAD), HSC/YAL AND HQ ACC/CEVC

- SATISFIES AIR FORCE HIGH PRIORITY FY96 ESOH NEED # 95-T11

PROGRAM OBJECTIVE

- PRIMARY: INSURE COMPLIANCE AT ALL ACC BASES

- SECONDARY: USE INFO GENERATED FOR FUTURE/OTHER DEICING/ANTI-ICING EFFORTS

PROGRAM DESCRIPTION

- PHASE I
  - BASELINE CURRENT GOVERNMENT AND CIVILIAN DEICING/ANTI-ICING OPERATIONS AND TECHNOLOGIES
    - » USE QUESTIONNAIRE AND SITE VISITS
  - RECOMMEND OPERATION AND TECHNOLOGY IMPROVEMENTS FOR APPLICABLE BASES
    - » USE LITERATURE SEARCH AND TECHNOLGY REVIEW
- PHASE II
  - DEVELOP RECOMMENDATIONS INTO 10% DESIGN DOCUMENT FOR APPLICABLE ACC BASES

ACQUISITION STRATEGY

- USE ACC ENVIRONMENTAL COMPLIANCE AND ANALYSES SERVICES CONTRACT
  - DELIVERY ORDER CONTRACT
  - CONTRACTOR: ECOLOGY & ENVIRONMENT
  - CO: CAPT SCOTT BENZA, HQ ACC CONS LG/CE
  - D.O. AWARD: 25 APR 96

PROGRAM SCHEDULE

EVENTS	TENTATIVE DATES
DELIVERY ORDER AWARD	25 APR 96
KICK-OFF MEETING	13-14 MAY 96
PRE-SURVEY QUESTIONNAIRE	JUN 96
SITE VISIT JUSTIFICATION LTR	AUG 96
SITE VISIT PLAN	SEP 96
SITE VISITS	NOV 96 -MAR 97
LIT/TECH REVIEW REPORT	MAY 97
ACC INSTALL. MNGT. AND RECOMM. RPT	MAY 97
ACC CURRENT PRACTICE SUMMARY RPT	MAY 97
CUSTOMER CONCEPT DOCUMENTS	AUG 97

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SUMMARY

- DEICING HAS BECOME A VERY 'HOT' TOPIC
- PROGRAM TO INSURE ENVIRONMENTAL COMPLIANCE AT ALL ACC BASES
- GOOD OPPORTUNITY FOR MULTIPLE PARTIES TO PARTICIPATE IN FUTURE AF DEICING/ANTI-ICING EFFORTS

Briefing: ACC Deicing/Anti-icing Operations, Compliance Evaluation and Requirements Identification

Briefed by: **Capt. Paul Fronapfel**
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Summary:

HQ ACC/CEVC has initiated an effort to evaluate the deicing and anti-icing operations at 19 of its bases, including northern and mid-tier locations. Driving forces to develop this project are many. The environmental fate and effects of deicing and anti-icing chemicals have caused concern among both civilian and military institutions and special interest groups. Wildlife kills at ACC bases and rejection of MILCON projects desired by ACC/CEV at its bases have spurred its interest in developing suitable studies at bases which have deicing/anti-icing operations. The purpose of this study is to evaluate the compliance status at each base at the present time and into the 21st century. By evaluating the operations and management practices at each base, ACC/CEV can identify any requirements to ensure environmental compliance through operations, management, or infrastructure modifications. MILCON requirements and justifications will be developed through these efforts and make approval of projects at the Air Staff level more promising.

Drivers for evaluating the deicing and anti-icing operations and effects on the environment come mainly from the Clean Water Act and associated state and local requirements. NPDES discharge permits and non-storm discharge certification associated with SWPPPs can impose requirements on bases to reduce or eliminate any runoff to storm drainage associated with deicing and anti-icing operations. In addition, it is in the best interest of ACC to have a proactive approach to environmental compliance and pollution prevention concerns.

HQ ACC/CEV requested the assistance of AL/OEBW and HSC/YAQ in overseeing this project to insure compliance at applicable ACC bases with respect to anti-icing and

conducted through ACC's ECAS contract mechanism. The contractor selected for the project was Ecology and Environment, Inc. out of Lancaster, NY.

The first phase of this project includes developing and completing a questionnaire for 19 ACC bases regarding their requirements, operations, management, and infrastructure with respect to deicing and anti-icing operations. Using these questionnaires, which were sent to representatives of CE, BE, LG, and DO at each base, the contractor will develop a justification letter stating reasons to or not to conduct further studies at each base. The contractor will produce a sampling and analysis plan for each base as necessary, and attempt to conduct a site visit during some deicing/anti-icing operations at the ACC bases and up to three other civilian institutions and other DOD installations to observe the practices and facilities at each location.

Using information collected during the site visits, E & E will develop a recommendations report for each ACC facility indicating methods to reduce the environmental effects of the deicing/anti-icing chemicals through management, operational, facility infrastructure, or chemical changes. If appropriate, the contractor will develop a 10% design and justification for any MILCON requirements identified through the project to insure environmental compliance with federal, state, and local requirements.

In addition to developing a site-specific recommendations report, the contractor will submit a summary of a literature and technology review conducted to develop solutions for each base. This information can be shared with other agencies to assist with their studies or projects associated with deicing/anti-icing of aircraft and runways. The projected submission date for the literature/technology review report is May 97, and the project completion date is August 97.

Briefing on Requirements Analysis for Deicing

PROJECT BACKGROUND:
Outline

- Project Background
- Approach
- Findings
- Conclusions
- Recommendations

PROJECT BACKGROUND:
Objectives

Provide a Requirements Analysis of the issues and technologies surrounding the subject of aircraft and ground (e.g., runway, roadway) deicing that contains:

- Identification of Technology Group characteristics
- Clarification of similarities, differences and criteria for analysis
- Compendium of current commercial products and research efforts
- Identification of technology vendors, applications and cost
- Focus on resources future

PROJECT BACKGROUND: Focus of Deicing Needs

- Technology Need No. 914: Making aircraft deicing operations more environmentally "benign"
- Technology Need No. 918: Making ground deicing operations more environmentally "benign"
- Technology Need No. 2501: Consideration of Sodium Formate for the deicing of pavements
- Technology Need No. 2504: Degradation rates of chemicals with lower toxicity

PROJECT BACKGROUND: Regulatory Drivers and Guidelines

- National Regulations
  - Clean Water Act (CWA)
  - National Pollutant Discharge System (NPDES)
  - State NPDES Regulations
- Air Force Instructions
  - AF 32-4041 “Water Quality Compliance”
  - AF 32-1045 “Snow and Ice Control”

APPROACH:
Information Sources

- Government Sectors
  - Department of Defense, Air Force, Army Corps of Engineers
  - Environmental Protection Agency
  - Department of Transportation, Federal Aviation Administration, Federal Highway Administration
  - NASA
  - Government laboratories
  - State and county road departments

APPROACH:
Information Sources (cont.)

- Private Sector
  - Commercial airlines
  - Aircraft manufacturers
  - Private laboratories
  - Chemical companies
  - Other industries requiring deicing

APPROACH:
Information Sources (cont.)

- Other Sectors
  - University research
  - Institutes
  - Associations
  - Conferences
  - Symposia
  - Societies
  - International organizations

APPROACH:
Search Mechanisms

- Internet
- Dialog
- On-line databases
- National libraries
- Expert network

APPROACH:
Overall Criteria for Evaluation of Deicing/Anti-icing Products

ICE/SNOW MELTING EFFICIENCY

The use of more effective melting fluids or solids will decrease the amount of their use which may decrease harmful effects on the environment.

CORROSIVITY

Deicing and anti-icing agents used in and around aircraft, runways, taxiways and parking stalls cannot include salts or other chemicals known to be corrosive to aircraft.

COST EFFICIENCY

Although more effective solutions may have higher procurement costs, they may be more cost effective in the long term where damage to equipment and infrastructure is less.

APPROACH:

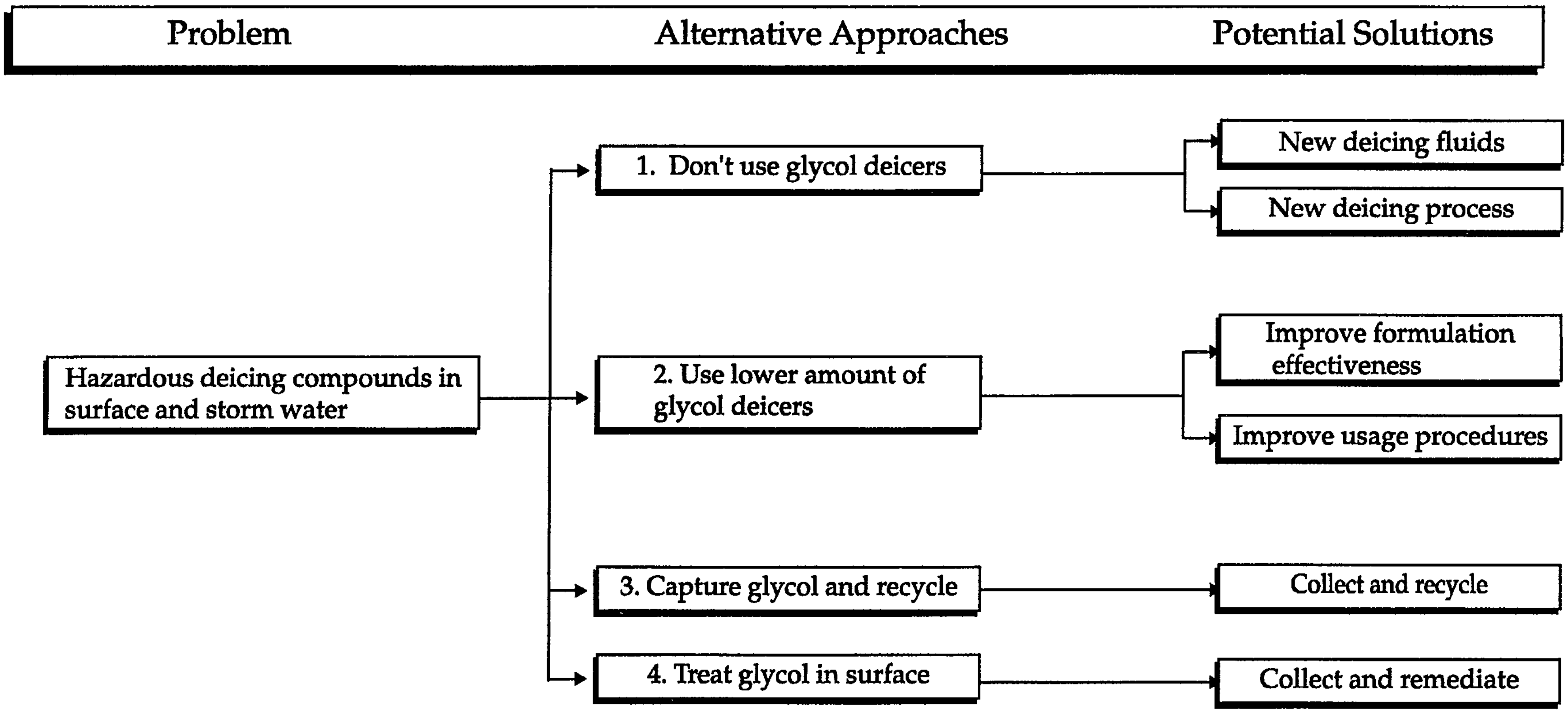
Overall Criteria for Evaluation of Deicing/Anti-icing Products (cont.)

REDUCE ADVERSE EFFECTS ON THE ENVIRONMENT:

The environmental effects of uncontrolled release of deicing/anti-icing chemical compounds include:

- High Biochemical Oxygen Demand (BOD) rates
- Nitrate enrichment of surface and groundwaters
- Impaired aesthetic water quality
- Ammonia formation from the degradation of urea
- Overall toxicity of such chemicals to terrestrial and aquatic life

APPROACH:
Deicing Problem Analysis



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FINDINGS:
Aircraft Deicing/Anti-icing Fluids Type I:

Removal of snow and ice already present on aircraft

Characteristics of deicing fluid:

- Glycol based
- Thin liquid
- Results in short holdover time 3-7 minutes

FINDINGS:

Aircraft Deicing/Anti-icing Fluids Type II:

Fluid applied to aircraft prior to precipitation or after deicing

Characteristics to deicing fluid:

- Glycol based
- Thickened liquid
- Reduces time and materials spent deicing aircraft
- Holdover time increased (10-30 minutes)

FINDINGS:
Aircraft Deicing/Anti-icing Materials

Materials currently in use by the Air Force and Industry:

Ethylene glycol: high toxicity to environment and aquatic life, low BOD, being phased out

Propylene glycol: not directly toxic to environment and aquatic life, but material exerts a high BOD

FINDINGS:

Aircraft Deicing/Anti-icing Infrastructure Improvements

- Runoff Mitigation Structure: structure that isolates facility runoff from airfield storm sewers
- Detention Basins and Pads: single or multiple collection areas which provide economical treatment of runoff
- Underground Storage Tanks: used for collection of deicing fluids, typically connected to a pad where aircraft are deiced

FINDINGS:
New Deicing Fluids

COTS Solutions or Research Projects	AIRCRAFT	ROADS/RUNWAYS
COTS	• No substitutes for glycol found • SAE Type II glycol with longer holdover times	• Several substitutes found that are not in AF Tech Order for roads/runways - sodium acetate, sodium formate, magnesium chloride, calcium magnesium acetate (all low or non-corrosive). Also potash is emerging as a deicer • On roads calcium chloride formulations for making ice and snow wetter
R&D	• NASA-Ames non-toxic glycol substitute (Type II) Aspen Systems non-toxic substitute review - proteins, polypeptides, & calcium magnesium acetate	• No R&D identified; however, road/runway deicing would benefit from substitute for propylene glycol

FINDINGS:
New Deicing Processes

COTS Solutions or Research Projects	AIRCRAFT	ROADS/RUNWAYS
COTS	• Infrared Deicing System • Pneumatic Impulse Ice Protection • AIRefrigeration Snow Blowing System	• No new processes identified
R&D	• Heating Element in Aircraft Coating	• Federal Highway Administration research on innovative anti-icing strategies

FINDINGS:
Improve Formulation Effectiveness

COTS Solutions or Research Projects	AIRCRAFT	ROADS/RUNWAYS
COTS	• No improved formulations identified	• More effective deicer formulation
R&D	• Aspen Systems improved formulations	• DOT/CRREL research on less expensive formulations for calcium magnesium acetate and potassium acetate

FINDINGS:
Improve Usage Procedures

COTS Solutions or Research Projects	AIRCRAFT	ROADS/RUNWAYS
COTS	• Deicing Gate	• More efficient spreaders
R&D	• Icing Laboratory studies on when to deice • NCAR research on when to deice	• Infrared Ice Accretion Measurement systems

FINDINGS:
Collect and Recycle

COTS Solutions or Research Projects	AIRCRAFT	ROADS/RUNWAYS
COTS	• Ground Deicing pads • Some commercial recycling of captured fluids	• No commercial products identified
R&D	• No R&D identified	• No R&D identified

FINDINGS:
Collect and Remediate

COTS Solutions or Research Projects	AIRCRAFT	ROADS/RUNWAYS
COTS	• Ground Deicing pads • Bioremediation of glycol runoff	• Bioremediation of glycol runoff
R&D	• No R&D identified	• No R&D identified

FINDINGS:

Aircraft Deicing/Anti-icing Improvements

- Anti-ice aircraft before storm events
- Properly mix deicing/anti-icing fluids
- Recycling of glycols
- Better ice detection methods

FINDINGS:
Aircraft Deicing/Anti-icing R & D: Air Force Funded Research

NASA Ames Research Center - non-glycol based fluid, biodegradable, non-toxic, low corrosivity, cost competitive

Aspen Systems, Inc. - synthetic glycol based fluid, small ratio of chemical mixture, results in less runoff material

FINDINGS:
Aircraft Deicing/Anti-icing R & D: Examples of Industry Process Research

Electrothermal Ice Protection System (ETIPS), Continental & Allied Signal of Canada - heating panel bonded to wing surface used to melt ice

InfraTek Pre-flight Deicing System, Process Technologies Inc. - Infrared technology used to deice aircraft

Heater Panel, TDG Aerospace - prevents formation of ice on aircraft wings

FINDINGS:

Runway and Road Deicing/Anti-icing Materials Currently In Use By Air Force and Industry

Materials	BOD	Roads	Runways
Potassium Acetate (liquid)	Low	X	X
Sodium Acetate (powder	Low	X	X
Sodium Formate (powder)	Low	X	X
Calcium Magnesium Acetate	Med.	X	
Urea	High	X	
Calcium Chloride	High	X	
Sodium Chloride	High	X	
Magnesium Chloride (liquid)	High	X	

FINDINGS:
Chemical Use Strategies - Liquid vs. Solid Forms and/or Combinations

Benefits

- Efficiencies in liquid chemical applications (less materials used due to initial prevention of ice bond formation vs. breaking of existing ice bond)
- Reduction of environmental consequences (due to less chemicals and reduced of chemical applications when using liquid chemicals or combination)
- Cost trade-off (use of less materials may result in cost savings)
- Performance (studies being conducted to determine criteria for liquid chemical applications)

FINDINGS:

Deicing and Anti-icing Strategies

- Preventive (liquid anti-icing prevents formation of pavement ice bond) vs. reactive (deicing breaks existing ice bond)

- Weather factors (can determine whether to use deicing chemicals or anti-icing chemicals; ice vs. snow or extreme cold vs. mild freeze temperatures)

FINDINGS:

New Developments in Spreader/Application Equipment

- Improved spreaders and spreader patterns
- Improved spreader equipment to distribute liquid, solid and liquid/solid chemical combinations

FINDINGS:
Observations

- Information received to date indicates that there is no appropriate material substitute for glycols used in aircraft deicing/anti-icing.
- Most industry efforts focus in the areas of process substitution rather material substitution.
- Change in process can lead to more efficient usage of chemicals and therefore reduced environmental impacts, with current materials.

FINDINGS:
Organizations Performing Deicing/Anti-icing Research

- Strategic Highway Research Program (SHRP)
- Federal Highway Administration (FHWA)
- US Army Corps of Engineers - Cold Regions Research & Engineering Laboratory (CRREL)
- International Community (Transport Canada)
- State Departments of Transportation
- Air Force Labs (Wright, Armstrong)

FINDINGS:
Research and Development

- Propylene glycol (advanced performance in freeze testing and in conjunction with other chemicals)
- Corrosion inhibitors (improvements to corrosion inhibitor formulas reduce corrosion in deicing chemicals, such as potassium acetate)

Conclusions

- Deicing affects a much larger audience than the Air Force; although Air force operations and performance requirements may be different
- Research on glycol substitutes is limited
- COTS products exist for capture and recycling or remediation of aircraft glycol runoff
- Advances in operations, management and training relative to deicing have been made in the commercial and local government sectors
- There are several COTS substitutes for deicing roads and runways
- There are COTS equipment to maximize road/runway deicing efficiencies

Recommendations

- Focus on process improvements in the use of glycols for deicing of aircraft, to include review of the Deicing tech order, training, and other procedural issues
- Further integrate anti-icing programs
- Continue to monitor research on glycol substitutes
- Consider a technology evaluation on COTS for capture and recycling or remediation of glycol fluids from aircraft deicing operations
- Test alternative chemicals (not in AF Snow and Ice Control RFI) for roads and runways

Recommendations (cont.)

- Promote exchange of information on AF efficiencies in using products, equipment and techniques for aircraft, road and runway deicing
- Monitor international and national standards groups work on deicing
- Follow up all research identified as it evolves and evaluate usefulness to AF

Briefing: **Requirements Analysis for Deicing (The HSC/XRE Study)**

Briefed by: **Evelyn McDonald**
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Summary:

HSC/XRE conducts an annual survey of Air Force environmental, occupational health and safety needs. As part of this process, requirements analyses are conducted on related groups of needs.

This study addressed the subject of aircraft and ground (e.g., runway and roadway) deicing. The objectives were twofold: 1) to identify commercial products, procedures, and infrastructure changes relative to deicing and 2) to identify commercial and governmental research into deicing.

The team reviewed the needs statements for characteristics, similarities and differences and developed criteria for analyzing potential solutions. The team then developed a compendium of current commercial products and research efforts, including information on technology vendors, applications, and costs.

HQ Air Force Center
for
Environmental Excellence

Introduction to Clean Water Act

Presented by
Mr. Johnny Combs, P.E., REM
AFCEE/CCR-D (Dallas)

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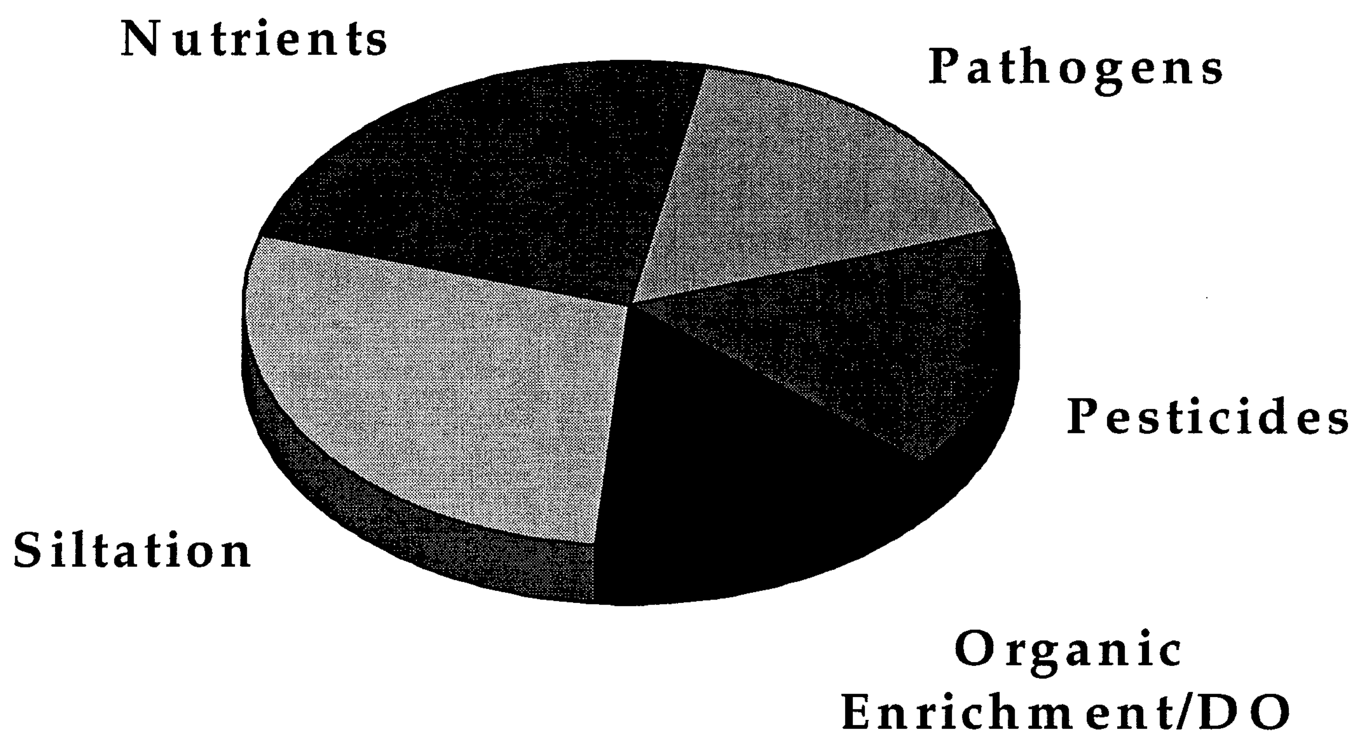
1972 Amendments to the Federal Water Pollution Control Act (FWPCA) - "Clean Water Act"

- **"to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."**
- **Two Main Goals:**
  - Eliminate the discharge of pollutants into navigatable waters by 1985.
  - Achieve an interim water quality level that protects and propogates fish, shellfish, and wildlife and supports recreation in and on the water, where attainable.

Status of the Waters of the U.S.



CWA Compliance Strategy

- **EPA developed the National Pollutant Discharge Elimination System (NPDES) permit for industrial/municipal point sources**
- **1987 CWA Amendments added phased storm water (i.e. non point sources) permits for industrial/ municipal facilities**

Penalties for Non Compliance

- Criminal (per violation)
  - Negligent - $25,000 and 1 year in prison
  - Knowing - $50,000 and 3 years
  - Endangerment - $250,000 and 15 years
- Civil - $25,000/day
- Administrative - $10-125,000

NPDES Permit Options

- Individual NPDES Permit issued by EPA
- Individual NPDES Permit issued by State
- Storm Water NPDES Permit issued by EPA
- Storm Water NPDES Permit issued by State

Where Does Deicing Come In?

- Deicing is covered as a "process wastewater" under the NPDES Permit (Individual or Storm Water)
- EPA prohibited a condition know as "Dry Weather Discharge"
  - Dry Weather Discharge - deicing chemicals reaching the drainage system under their own flow

NPDES Permit Requirements

- Implement a Storm Water Pollution Prevention Plan
- Identify sources of deicing
- Monitor runoff for deicing components
- Eliminate dry weather deicing discharges
- Train employees on P2 techniques and plan
- Implement BMP to eliminate/reduce deicing

State Reaction to Deicing

- "4 times the COD load from one airport during deicing than all POTWs in the state for the entire year."
- "Not a problem, reaction is so delayed the deicing chemicals are in another state before they impact the river."
- "Definitely the CWA issue of the 90's"

Summary

- Deicing runoff is responsible for significant degradation of waters quality in the U.S.
- NPDES permits require BMPs to eliminate/reduce deicing runoff
- Attempt procedural before structural solutions
- Be sensitive to local demands/concerns

STORM WATER REGULATIONS FOR DEICING ACTIVITIES

Note:

This information was provided by Theresa Finke. Mrs. Finke works water issues for HQ AFMC/CEVC. Our intent in asking Mrs. Finke to develop this write-up is to provide you, the reader, with a better understanding of storm water regulations.

Mrs. Finke would have attended our de-icing crossfeed except she was on maternity leave.

GENERAL INFORMATION

Deicing activities are a concern due to the toxic and oxygen-depleting components of deicing chemicals. These chemicals can run off into water bodies causing violations of National Pollutant Discharge Elimination System (NPDES) permits.

In Nov 90, the Environmental Protection Agency (EPA) published NPDES storm water regulations that required specific industrial categories to be covered under a storm water permit. Bases can obtain coverage under an individual, federal or state general/baseline, or the multi-sector permit. The federal general permit was published in the Federal Register (FR) dated 9 Sep 92, and the multi-sector permit was issued in final form in the 29 Sep 95 FR. These permits include monitoring requirements for air transportation facilities that use deicing chemicals.

The general and multi-sector permits cover residual chemicals remaining on the runway/ramp from deicing/anti-icing activities that become part of the storm water runoff. Dry weather discharges from airport deicing/anti-icing operations are not authorized by these permits. A dry weather discharge occurs when deicing chemicals leave the runway/ramp under their own flow and discharge into the storm drainage system.

Many states consider runoff from deicing activity to be an industrial process wastewater discharge and subject to individual NPDES permit authority. Individual permits, unlike the general and multi-sector permits, have numerical parameter limits that must be monitored and met. If a dry weather discharge will occur, an individual permit is required. Bases must determine if they can meet the prohibition of dry weather discharges to decide which permit to apply for.

Most state general permits are very similar to the federal general permit. As stated, an individual permit typically has more specific and stringent requirements than the multi-sector or general permits. The requirements must be reviewed on a site-specific basis for each installation. This paper provides a comparison of the federal general and the multi-sector permits. The ultimate goal is "zero discharge" of glycols to water bodies.

STORM WATER POLLUTION PREVENTION PLANS

Multi-Sector and General: A storm water pollution prevention plan must be developed for facilities covered by these permits. The pollution prevention plan identifies potential sources of pollution which are expected to affect the quality of storm water discharges and describes the implementation of practices which are to be used to reduce pollutants in these discharges. The plan consists of many items, however, only those items specific to deicing activities are mentioned in this paper.

The plan should address all aspects of aircraft and runway deicing/anti-icing operations, including quantities used (totals and volume per surface area) and stored, application, handling and storage procedures. Facilities shall provide a narrative description of "best management practices" (BMPs) which will be implemented to control or manage storm water runoff from areas where deicing/anti-icing operations occur in an effort to minimize or reduce the amount of pollutants being discharged from the site.

The following are considered BMPs for deicing activities (These are only some of the available options. No particular practice must be implemented. However, if the plan states that a particular BMP will be implemented, then the facility is required to comply with it):

Evaluate present chemical application rates to ensure against excessive over application.

Emphasize anti-icing operations in lieu of deicing.

Consider installing runway ice detection systems (RIDS) which monitor runway temperatures.

Consider pre-wetting the deicing chemical to improve adhesion to the iced surface.

Use chemicals which have less of an environmental impact on receiving waters

Establish a centralized deicing station that would allow the spent deicing/anti-icing chemicals to be collected and then disposed of to sanitary sewage facility, retention and detention ponds, or by recycling, etc.

Move critical aircraft into hangars before icing events to minimize deicing required

Delay flight schedule at Southern Tier bases to allow ice to thaw

Reduce the nozzle size of the deicing hose to reduce volume of chemical used

Use temporary containment pads to capture fluid for treatment at low use bases

Use modified street sweepers to pick up the deicing fluid from the ramp after aircraft deicing operations

Plug storm drains and pump deicing fluid out for treatment

POLLUTION PREVENTION TRAINING

Multi-Sector and General: Pollution prevention training should address topics such as spill response, good housekeeping, material management practices and deicing/anti-icing procedures for personnel responsible for implementing activities which may impact storm water. EPA recommends that facilities conduct training annually at a minimum. However, more frequent training may be necessary at facilities with high turnover of employees or where employee participation is essential to the storm water pollution prevention plan.

COMPREHENSIVE SITE COMPLIANCE EVALUATION

Multi-Sector and General: The plan must describe the scope and content of comprehensive site evaluations that will be conducted to confirm the accuracy of the description of potential pollution sources, determine effectiveness of the plan, and assess compliance with terms and conditions of the permit. The evaluations must be conducted at least annually. The plan must be revised as appropriate within 2 weeks if significant problems are found during each evaluation. Changes in the measures and controls must be implemented in a timely manner and no later than 12 weeks after completion of the inspection.

INSPECTIONS

In addition to or as part of the comprehensive site evaluation, inspections shall be conducted. The inspections are typically visual and help ensure that BMPs are operating and properly maintained. The comprehensive site evaluation is more detailed and is intended to provide an overview of the entire facilities' pollution prevention activities.
Multi-Sector: Once per week for areas where deicing operations are being conducted.

General: At appropriate intervals specified in the pollution prevention plan

ANNUAL LOADING ESTIMATES

Multi-Sector: All facilities that use more than 100,000 gallons of glycol-based deicing/anti-icing chemicals and/or 100 tons or more of urea on an average annual basis shall prepare estimates of annual pollutant loadings resulting from discharges of spent deicing/anti-icing chemicals from the facility. The loading estimates shall reflect the amounts of deicing/anti-icing chemicals discharges to separate storm sewer systems or surface waters, prior to and after implementation of the facility's storm water pollution prevention plan. Such estimates shall be reviewed and certified by an environmental professional (engineer, scientist, etc.) with experience in storm water pollution prevention. The environmental professional need not be certified or registered.

General: No requirement to calculate annual loading estimates

FACILITIES REQUIRED TO CONDUCT SAMPLING

Multi-Sector: Airport facilities that use more than 100,000 gallons of glycol-based deicing/anti-icing chemicals and/or 100 tons or more of urea on an average annual basis. The "average annual usage rate" is determined by averaging the total amounts of deicing/anti-icing chemicals used at the facility for the three previous calendar years. In determining the fluid amounts of deicing/anti-icing chemicals used at a facility, facilities should use the pre-dilution volume.

General: Airports with over 50,000 flight operations per year

ANALYSES REQUIRED AND LIMITS

Multi-Sector:

Pollutants of Concern	Monitoring Cutoff Concentrations
BOD	30 mg/l
COD	120 mg/l
Ammonia	19 mg/l
pH	6.0 to 9.0 s.u.

In cases where the average concentration for all grab samples analyzed for a parameter exceeds the cutoff concentrations, EPA expects permittees to place special emphasis on methods for reducing the presence of those parameters in storm water discharges. Monitoring is required in the second year for the pollutants of concern. If the pollutant of concern levels are above the monitoring cutoff concentration values, then monitoring is also required in the fourth year of the permit to determine the effectiveness of any BMPs that were implemented.

General:

Parameter
Oil and grease
BOD
COD
Total suspended solids
pH
The primary ingredient used in the deicing materials used at the site (e.g., ethylene glycol, urea, etc.).

There are no concentration limits for this permit. However, facilities are expected to implement BMPs to reduce those parameters found in storm water discharges based on sampling results. A common sense approach should be taken with regards to the need for implementation of BMPs (i.e., if levels are reasonable or are not elevated during times of deicing activities, then no BMPs would need to be implemented). Pollution prevention techniques and procedural BMPs should be implemented before any structural BMPs are considered.

MONITORING FREQUENCY

Multi-Sector: Facilities must monitor four times during the second year of permit (Dec-Feb) coverage when deicing/anti-icing activities are occurring and from outfalls that receive storm water runoff from those areas. At the end of the second year of permit coverage, a facility must calculate the average concentration for all grab samples analyzed for each parameter on an outfall by outfall basis. If the average concentration for all grab samples analyzed for a pollutant of concern is greater than the monitoring cutoff concentration, then the permittee is required to conduct monitoring during the fourth year of the permit. No monitoring is required during the first, third, and fifth years of permit coverage.

General: Monitoring must be conducted once per year during deicing activities.

COMPLIANCE DEADLINES

Multi-Sector: 29 Mar 96 for filing the application for the permit
25 Sep 96 for development of pollution prevention plan
25 Sep 96 for compliance with the plan

General: 1 Oct 92 for filing the application for the permit
1 Apr 93 for development of pollution prevention plan
1 Oct 93 for compliance with the plan

T. Finke/HQ AFMC/CEVC/DSN 787-5878/4 Apr 96

De-icing/Anti-icing Technologies and Case Studies

Technology Cross-Feed

PRESENTED TO
Air Force Materiel Command

August 21, 1996

PRESENTED BY
The National Defense Center For Environmental Excellence NDCEE

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OPERATED BY:

CONCURRENT TECHNOLOGIES CORPORATION
1450 SCALP AVENUE
JOHNSTOWN, PA 15904

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Outline

- Overview of the National Defense Center for Environmental Excellence
- Summary of Findings from Two Air force De-icing Reports
- Survey Success Stories of Alternative Technologies for De-icing

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Appendices

- Appendix 1 – Definitions
- Appendix 2 – De-icing Case Studies
- Appendix 3 – References

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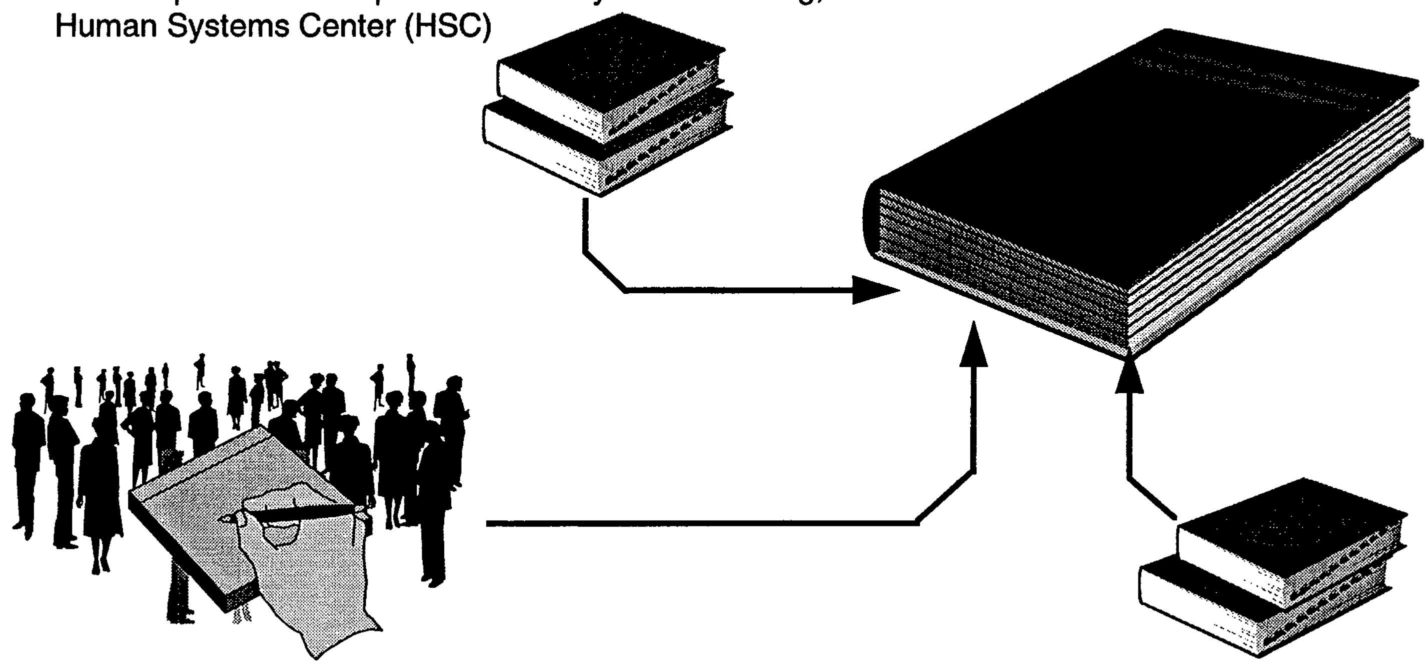
Methodology

Air Force Reports

1. Exploring Available De-icing Technologies, Air Force Logistics Management Agency (AFLMA)
2. Draft Report on the requirements analysis for de-icing, Human Systems Center (HSC)

NDCEE Review & Observations



De-icing Case Studies

Additional References

NDCEE

Rating Criteria

- Biochemical Oxygen Demand (BOD)
- Ecological Toxicity/Hazard
- Regulatory Issues
- Ice Melting Efficiency
- Implementation
- Maintenance
- Cost Efficiency
- Recyclability
- Materials Compatibility
- Maturity
- Ammonia/Nitrate Formation

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Aircraft De-icing

Chemicals

Rating Criteria	Propylene glycol (Baseline)	Ref.	NASA Ames	Ref.	Proteins, alanine-rich polypeptides & CMA (Calcium magnesium acetate)	Ref.
BOD	−	2				
Ecological toxicity/hazard	+	2				
Regulatory issues	−	2				
Ice melting efficiency	+	2				
Implementation	+					
Maintenance	+					
Cost efficiency	−					
Recyclability	O	2				
Material compatibility	+					
Maturity	+		−	2	−	2

Key
+ = Favorable
O = Neutral
− = Unfavorable
No. = Reference Source

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Aircraft De-icing
Equipment

Rating Criteria	"Cherry picker" type truck (Baseline)	No.	Air blast system	No.	Automated deicing platforms	No.	Radiant heat de-icer	No.	Clean wing	No.	Wing surface heaters & ice removal equipment	No.
BOD	O		+	8	O	1	+	2	+		+	
Ecological toxicity/hazard	O		+	8	O	1	+	2	+		+	
Regulatory issues	O		+	8	–	1	+	2	+		+	
Ice melting efficiency	O		+	8	O	1	+	2	+	2	+	2
Implementation	+		+	6	+	1	O	2	O		–	
Maintenance	O		+		O		O		O		O	
Cost efficiency	O		+	8	O	1	+	2	+		O	
Maturity	+		+	6	+		–	2	–		–	

Ellsworth AFB, SD
airblast system for aircraft
and runway de-icing

Key
+ = Favorable
O = Neutral
– = Unfavorable
No. = Reference Source

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Aircraft De-icing
Capture of Runoff

Rating Criteria	All fluids to storm sewers (Baseline)		Heavy mat capture system		Permanent de-icing pad	
BOD	−		+	1	+	2
Ecological toxicity/hazard	−		+	1	+	2
Regulatory issues	−		+	1	+	2
Implementation	+		+	1	−	2
Maintenance	+		O		O	
Cost efficiency	+		O		O	
Maturity	+		+		+	

Mirabel Int'l Airport
Mirabel, Canada
centralized de-icing center

Baltimore/Washington Int'l
2 centralized de-icing facilities

Detroit Metro Wayne Co. Airport
Detroit, MI
runoff held in pond, discharged to sanitary sewer

Key
+ = Favorable
O = Neutral
− = Unfavorable
No. = Reference Source

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Aircraft De-icing
Reclamation/Treatment

Rating Criteria	Free runoff (Baseline)		Bulk recovery		Collection service		Biological filter		Spill biotreatment	
BOD	−		+	1	+	1	+	1	O	2
Ecological toxicity/hazard	−		+	1	+	1	+	1	+	2
Regulatory issues	−		+	1	+	1	+	1	O	
Implementation	+		−	4	+	1	−		+	2
Maintenance	+		−		+	1	−		+	2
Cost efficiency	+		−	2	O		+	4	O	
Maturity	+		+		+		O	1	O	

Pittsburgh Int'l Airport
Pittsburgh, PA
distilled condensate biotreatment

Albany County
Albany, NY
aerobic digester

Dorval Airport Montreal, Canada
planning to recover surrounding airports' fluid

Lester B. Pearson Int'l
Toronto, Canada
distillation recovery

Key
+ = Favorable
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− = Unfavorable
No. = Reference Source

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Runway De-icing
Chemicals

Rating Criteria	Glycol and urea (Baseline)		Potassium acetate		Sodium acetate		Sodium formate		Isopropyl alcohol		CMA	
BOD	−	2	+	2	+	2	+	2			O	2
Ammonia/nitrate formation	−	2	+	2	+	2	+	2	+	2	+	2
Ecological toxicity/hazard	−	2	+	2	+	2	+	2			+	2
Regulatory issues	−	2	+	2	+	2	+	2			+	2
Ice melting efficiency	+	2	+	9	+	2					O	2
Implementation	+		O		O		O				O	
Cost efficiency	O		−	2					+	2	−	2
Material compatibility	+	2	+	2	+	2	+	2	+	2	+	2
Maturity	+		+		+		+		+		+	

Key
+ = Favorable
O = Neutral
− = Unfavorable
No. = Reference Source

Lester B. Pearson
Toronto, Canada
potassium acetate
and
sodium formate

Albany County - Albany, NY
potassium acetate and urea

Detroit Metro Wayne Co. Airport
Detroit, MI
potassium acetate

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Runway De-icing
Equipment

Rating Criteria	Spreader Truck (Baseline)		Specialized airport sprayer/spreader		Infrared measurements system	
BOD	O		+	2	+	2
Ecological toxicity/hazard	O		+	2	+	2
Regulatory issues	O		+	2	+	2
Ice melting efficiency	O		+	2	+	2
Implementation	O		O		O	
Maintenance	O		O		O	
Cost efficiency	O		+	2	+	2
Maturity	+		+	2	−	2

Ellsworth AFB, SD
airblast system unit

Detroit Metro Wayne Co. Airport
Detroit, MI
new Batts sprayer/spreader for potassium acetate

Key
+ = Favorable
O = Neutral
− = Unfavorable
No. = Reference Source

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Runway De-icing
Operational Modifications

Lester B. Pearson Int'l, Toronto, Canada
Spray anti-icer before storms

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Aircraft De-icing
Operational Modifications

- Baltimore/Washington Int'l, Baltimore, MD
  centralize de-icing activities

- Calgary Int'l Airport, Calgary, Canada
  remove snow prior to de-icing

- Minneapolis-St. Paul Int'l, Minneapolis, MN
  improve aircraft positioning when de-icing

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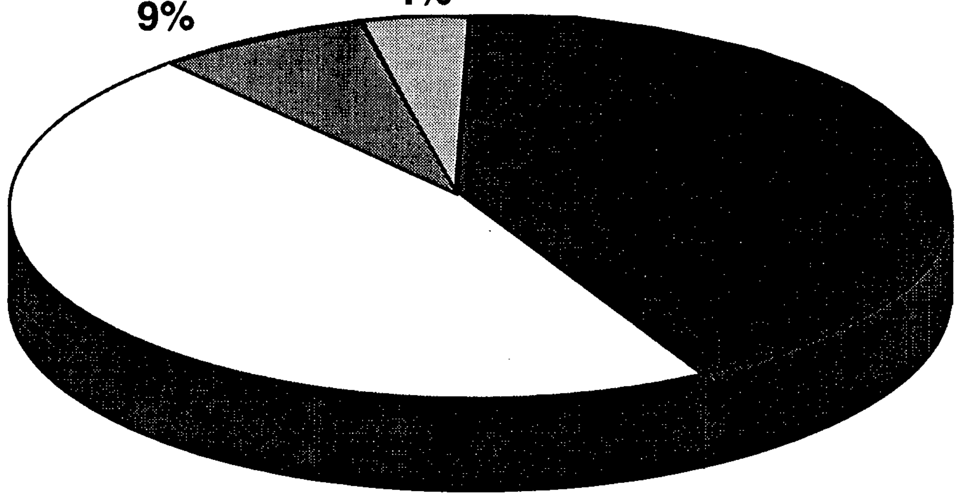
Patent Search* Results as Trend Indicators of Technology Alternatives for Aircraft De-icing



*Patent search performed by HSC

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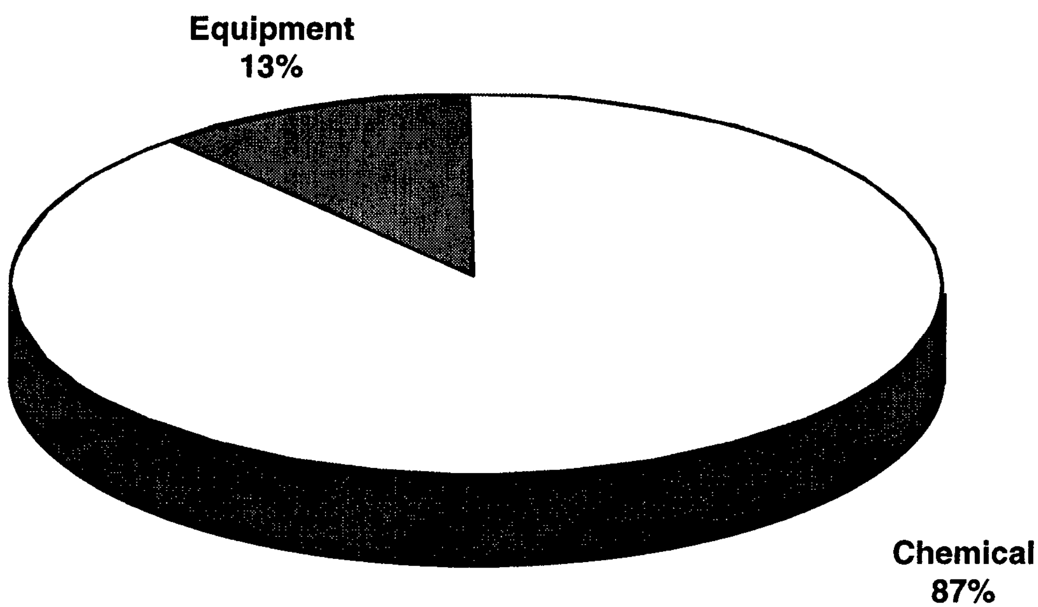
Patent Search* Results as Trend Indicators of Technology Alternatives for Runway De-icing



*Patent search performed by HSC

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Factors Considered When Choosing Alternatives

Case Studies Results

Aircraft De-icing

- Regulations
- Cost (capital)
- Operational requirements
- Cost (operating)
- Application rate (de-icing time)
- Glycol use
- Subsequent treatment
- Size and space requirements
- De-icing results

ranked by frequency of use

Runway De-icing

- Environmental impact of urea
- Regulations
- Cost
- Application rate
- Availability
- De-icing results
- Equipment needs

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Benefits of Switching to Alternatives

Case Studies Results

Aircraft De-icing

- Speed up de-icing
- Improved de-icing quality
- BOD down or within imposed criteria
- De-icing fluid use decreased
- Collection of fluid increased

Runway De-icing

- Ammonia and nitrates down
- BOD down or within imposed criteria
- Improved application rate
- Collection of fluid increased

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De-icing Alternatives In Use

Case Studies Results

	Aircraft De-icing	Runway De-icing
Chemical	• Propylene glycol	• Potassium acetate • Sodium formate
Equipment	• Adjustable flow nozzle • Manhole control inserts • Airblast unit	• Sprayer/spreader trucks • Specialized liquid spray bars • Airblast unit
Capture of Run-Off	• Trenches and dedicated drains • Plug system in existing drains • Modular tanks • Glycol recovery vehicules (vacuum)	• Ponds

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De-icing Alternatives In Use

Case Studies Results

	Aircraft De-icing	Runway De-icing
Reclamation Recycling & Treatment	• Evaporator/distillation unit • Aerobic digester • Land farming • Natural pond system • Lined pond • Aerated pond • Public treatment plant	• Public treatment plant
Operational	• Centralized de-icing • Remove snow prior to de-icing • Aircraft positioning when de-iced • Aircraft in hangar when not in use	• Anti-icer sprayed before storm • Snow blown off before de-icing

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NDCEE Recommendations

- Continue promotion of information sharing
- Expand reference source
- Short-term: consider the following alternatives where possible;
  - Air blast systems
  - Centralized de-icing
  - Containment system
  - Optimized disposal method
  - Potassium acetate and sodium formate
  - Improved operations
- Long-term: promote development of alternative technologies for anti-icing and de-icing of aircrafts

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Appendix 1

Definitions

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Rating Criteria	Issue
BOD	Increases load on municipal wastewater treatment systems or receiving body of water. Low oxygen level has detrimental effects on aquatic life.
Ecological toxicity/Hazard	Associated with the manufacturing, transport, storage, and use of the de-icer/anti-icer (chemical toxicity)
Regulatory Issues	Generates a waste stream that must meet certain regulations
Ice melting efficiency	Must be able to melt ice or prevent ice formation.
Implementation	Requires efforts, training, and re-writing of procedures. For capture systems, the flexibility of the application to a variety of aircraft, quick assembly and disassembly, and mobility are desired.

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Rating Criteria	Issue
Maintenance	Can be a substantial part of the operating cost. Down time of equipment can create congestion or delays.
Cost efficiency	Can be high for the alternatives (exclusive of waste generation charges)
Recyclability	Can reduce the toxicity of the waste stream.
Material compatibility	Promotion of corrosion of aircraft aluminum surfaces or runway construction materials can happen.
Maturity	A technology/practice that has been proven in commercial/ Air Force applications is considered mature.
Ammonia / Nitrate	Urea degrades to ammonia and then to nitrate. Ammonia is toxic to aquatic life, and nitrate causes eutrophication of waters.

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Appendix 2

De-icing Case Studies

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AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS DMW-1

Detroit Metro Wayne Co. Airport, Detroit, Michigan, Contact: Catherine S. Morse (313) 942-3996 Fax: (313) 942-0689

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Ethylene Glycol, Propylene Glycol	Potassium Acetate (E-36)
Vendor	several, ordered by tenants	Chevron, Ashland Chemicals, Warren, MI
Amount of de-icing fluid used	Propylene Glycol: 855,000 gal/yr (1995-1996) Ethylene Glycol: 86,520 gal/yr	163,368 gal/yr
Previous chemical used	None	An Ethylene Glycol and Urea mixture
Equipment		
Type used now	Hundreds of trumps de-icing trucks	Four Batts de-icer, one International de-icer 3,000 gallons capacity
Vendor	FMC (Orlando, FL)	CE Pollard, Detroit, MI
Previous equipment used	Trumps	Two 2,000 gallons tankers/GM tractors
Containment System		
Type used now	Hold in pond, discharged to sanitary sewer	Held in ponds, discharged to local county drains.
Vendor		
Previous equipment used		
Run-off Treatment or Recycling Equipment		
Type used now		
Vendor		
Previous equipment used		
Recyclability		
Operational Modifications		
Changes made	All runoff goes to Apron collection system	Changed chemical used
Gain	85% of glycol is captured and goes to sanitary	Better water quality re: stormwater runoff
Factors that were considered in selecting the above alternatives	Compliance with Federal NPDES permit	(same as with aircraft)
Other alternatives considered	Recycling	(same as with aircraft)
Testing done before or after implementation	Yes, some	Yes, some
Impact of alternatives on operations (de-icing time, quality and maintenance)		None to minor
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	Improved water quality	Great improvement in BOD, ammonia & DO levels
Problems implementing alternatives	Minor	Minor
Cost of alternatives compared to previous process	+$3.5 million	
Material compatibility problems with alternatives	No	No
How long have you used the alternative	Three-four years	Two years
Any additional information you feel should be stated here		

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS PIT-2

U.S. Air & Pittsburgh International Airport, Pittsburgh, PA,
Contacts: Mike Athanas (Aircraft) (412) 472-1690 Fax: (412) 472-1690 Brad Penrod (Runways) (412) 472-3677 Fax: (412) 472-3636

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Propylene Glycol	Ethylene Glycol, Urea Potassium Acetate
Vendor	Arco Chemical	Old World Industries, Hydrocurb, Old World Industries
Amount of de-icing fluid used	1.3 millions gal/yr	84,800 gal/yr EG , 700 tons/yr Urea, 56,950 gal/yr PA
Previous chemical used	Ethylene Glycol	None
Equipment		
Type used now	Telescoping Booms, De-icing trucks	Sand spreaders/ 4,000 gallons liquid container trucks
Vendor	Simon R.O./ FMC, Lewylln	Ford/Chevy Dodge Duer Brother/Batts corp
Previous equipment used	De-icing Trucks	Not Applicable
Containment System		
Type used now	Modular Tanks	None
Vendor	Modutank	
Previous equipment used	None	
Run-off Treatment or Recycling Equipment		
Type used now	Distillation, Biotreatment of condensate	None
Vendor	Zenon/Coastal Fluid Tech.	
Previous equipment used	None	
Recyclability	30-70%	
Operational Modifications		
Changes made	Increase size of reflux column	None
Gain	Less downtime for recycling	Not Applicable
Factors that were considered in selecting the above alternatives	Length of time required to de-ice Quality of de-icing	Not Applicable
Other alternatives considered	Collection followed by direct release to local POTW	None
Testing done before or after implementation	None	None
Impact of alternatives on operations (de-icing time, quality and maintenance)	Improved quality of de-icing as well as timing	None
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.		

	Aircraft	Runways
Problems implementing alternatives	No	No
Cost of alternatives compared to previous process	$12 million	Not Applicable
Material compatibility problems with alternatives	No	No
How long have you used the alternative	Approximately 3 years	Not Applicable
Any additional information you feel should be stated here		

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS MSP-3

MSP, Minneapolis-St. Paul International Airport Contact: Richard B. Keinz (612) 726-8134 Fax: (612) 726-5296

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Type I, Type II, and UCAR ULTRA (Type IV)	Prilled Urea is primary chemical utilized. Field testing has been performed with potassium acetate (liquid product) and sodium formate (granular product).
Vendor	Arco (PG products), Union Carbide (EG products), Octagon (PG products)	Urea- Local vendor, Sodium Formate - Hoechst Canada Inc., Potassium acetate-Cryotech
Amount of de-icing fluid used	1995/96 season: 565,400 gallons pure product 1994/95 season: 392,000 gallons pure product 1993/94 season: 450,000 gallons pure product	Urea- approximately 750-1,000 tons per winter season. Sodium formate and Potassium acetate-test amounts
Previous chemical used	Same as above	Urea only
Equipment		
Type used now	Boom trucks with open and closed baskets for operator.	Urea- dump trucks with broadcast components (applied with sand). Sodium formate- dump trucks with broadcast components. Potassium acetate- trucks with specialized liquid spray bars.
Vendor	Unknown--contact airlines.	Dump trucks unknown, Liquid spray application trucks- Batts Equipment
Previous equipment used	Unknown--contact airlines.	Unknown
Containment System		
Type used now	Plug structures installed in existing storm sewer lines at aircraft de-icing locations. Night evacuation from in-line storage with tanker trucks and transfer to storage ponds. From ponds meter to local POTW.	Not applicable
Vendor	Not applicable	Not applicable
Previous equipment used	None	Not applicable

Run-off Treatment or Recycling Equipment		
Type used now	Glycol-impacted storm water (GISW) is contained as described in above and metered to local POTW treatment plant.	Run-off from all four watersheds on the airport is routed through detention ponds prior to discharge. However, these currently are not large enough to achieve treatment in the cold winter/spring months.
Vendor	Not Applicable	Not applicable
Previous equipment used	None	Not applicable

	Aircraft	Runways
Recyclability	Dependant upon glycol concentration in GISW	Not recyclable
Operational Modifications		
Changes made	Plug/pump containment program began in 1993/94 winter. Has been enhanced every year by adding the number of plug installations, improving drainage infrastructure around some containment locations, and improving aircraft positioning over contained storm water intakes.	Field testing with alternative (to urea) products.
Gain	Significant improvements in glycol capture performance from year to year.	Generally positive results, particularly with sodium formate.
Factors that were considered in selecting the above alternatives	Environmental regulatory requirements, operational considerations, long-term planning issues (capital expenditures vs. operating expenditures), other factors.	Desire to ultimately eliminate the use of urea because of its nitrogen content and potential for environmental impact.
Other alternatives considered	GISW containment: vacuum sweepers, dedicated de-icing pads, synthetic pads, trench drains, and glycol impacted snow containment. GISW management: on-site aerobic and anaerobic treatment; and recycling reclamation (on-airport reuse, third party re-sale, or direct resal for coal pile freeze point depressant).	None, really. Considered treatment, but not viable.
Testing done before or after implementation	Lab-scale testing has been done on the use of reverse osmosis as a potential bulk dewatering step in a glycol reclamation process. Lab and pilot-scal testing was also done on GISW treatability (biological treatment). At this point neither on-site glycol reclamation nor on-site GISW treatment have been implemented. They may be in the future.	Testing is currently being performed.
Impact of alternatives on operations (de-icing time, quality and maintenance)	Minimal impact on operations	Limited impact on operations--field testing only
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	During the 1995/96 season, approximately 66 percent of glycol entering the storm system was captured and treated. During the 1994/95 season this figure was approximately 55 percent and for the 1993/94 season it was approximately 36 percent.	Expect replacement of urea with alternative product(s) to decrease nitrates, ammonia formation, aquatic toxicity, and overall BOD. CBOD is expected to increase with full-scale usage of alternative product(s).
Problems implementing alternatives	No major problems.	Field testing only

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	Aircraft	Runways
Cost of alternatives compared to previous process	Annual costs for plug installation/removal, trucking, project management/oversight, and GISW disposal (combined) approximately $600,000 - $650,000 per winter season.	It is estimated that using sodium formate on a full scale would likely be three to four times more expensive per season for material purchase than has been the case with urea. There would also be additional product storage/handling development costs associated with the anticipated switch to sodium formate.
Material compatibility problems with alternatives	No	Not to our knowledge
How long have you used the alternative	Three winter seasons	Testing with potassium acetate: three seasons. Testing with sodium formate: one season.
Any additional information you feel should be stated here	Co-operative efforts with all aircraft de-icing fluid users and regulators is crucial to successful GISW containment and management. Retrofitting existing facilities to optimize GISW containment creates unique challenges.	Preference for a primarily liquid product based runway de-icer system vs. a primarily granular product runway de-icer system is highly airport specific. There are significant material storage (caking) and handling (dusting) difficulties associated with sodium formate relative to urea.

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS LBP-4

Lester B. Pearson International, Toronto, Canada Contact: Randy McGill (905) 676-5091 Fax: (905) 676-3555

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Ethylene Glycol	Potassium Acetate Sodium Formate
Vendor	UCAR	Hoechst
Amount of de-icing fluid used	3.5 million liters	51546 gallons
Previous chemical used	Same	Urea
Equipment		
Type used now	Cherry picker	Computer spray bar, sander/spreader
Vendor	Various makes	
Previous equipment used		Sander/spreader
Containment system		
Type used now	Sweepers + trench, drain dedicated	
Vendor	Pads + ponding, Transport Canada design	Ponds - drain to sanitary
Previous equipment used	prior to 1991 nothing	
Run-off Treatment or Recycling Equipment		
Type used now	Majority to sani some recycled	
Vendor	CCR Inland	
Previous equipment used	Evaporator Evaporator/distill	ponds - drain to sanitory
Recyclability	<30%, depends on collection facilities and ability to collect high glycol concentration run-off	
Operational Modifications		
Changes made	Flow control	Anti-icer sprayed before storm
Gain	yes	Quicker than urea application
Factors that were considered in selecting the above alternatives	Meet laws	Environment Improved application rate
Other alternatives considered	Yes	Yes, see Transport Canada HQ Reports
Testing done before or after implementation	Testing major Factor in evaluation + improvement	Yes
Impact of alternatives on operations (de-icing time, quality and maintenance)	Quicker de-icing, better quality	
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	BOD down significant	BOD appears up but still under limits. NH3 + N is down

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	Aircraft	Runways
Problems implementing alternatives	Yes, but normal	Yes, learning curve
Cost of alternatives compared to previous process	De-icer usage down, collection up	More expensive than Urea, cost going down now
Material compatibility problems with alternatives	No	No
How long have you used the alternative	Four years	Two years
Any additional information you feel should be stated here		

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS ANY-5

Albany County, Albany, NY Contact: Dave Logan, Ops Mgr. (518) 869-5481 Fax: (518) 452-3330

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Propylene Glycol	Urea, Potassium Acetate
Vendor		
Amount of de-icing fluid used	100,000 gal/yr	10-15 tons, 3,000 gal/yr
Previous chemical used		
Equipment		
Type used now		Waltes sander, Epoke spreader
Vendor		
Previous equipment used		
Containment System		
Type used now	Collection grates and pumped to two holding bassins. Capacity of 6 and 2.3 million gal	Not Applicable
Vendor		
Previous equipment used	Not Applicable	
Run-off Treatment or Recycling Equipment		
Type used now	Aerobic digester (to be implemented)	
Vendor	Zenon environmental services	
Previous equipment used		
Recyclability	<30%	
Operational Modifications		
Changes made	Aerobic digestion, Land farming	
Gain		
Factors that were considered in selecting the above alternatives	Cost, modifications to existing NPDES permit	
Other alternatives considered		
Testing done before or after implementation	Extensive analyticals for benchmark establishment	MSDS submittals, Environmental certification
Impact of alternatives on operations (de-icing time, quality and maintenance)		
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	Odor production Aerobic supply for activation	
Problems implementing alternatives	To be determined	
Cost of alternatives compared to previous process	To be determined	
Material compatibility problems with alternatives	To be determined	
How long have you used the alternative	To be determined	
Any additional information you feel should be stated here	To be determined	

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS CAL-6

Calgary Airport Authority, Calgary International Airport, Calgary, Canada Contact: Clark Norton (403) 735-1405 Fax: (403) 735-1418

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Ethylene Glycol (XLS4) Propylene Glycol (Killfrost)	Potassium Acetate (E36), Urea
Vendor	Union Carbide Canada Arco Chemical Co.	
Amount of de-icing fluid used	1,000,000 litres (1995/96)	
Previous chemical used		
Equipment		
Type used now	Trump DD1200:D40 John Beam Trump TD36,NTD40	Batts sprayer for E36 Truck monted spreader for Urea
Vendor	Stanray 2180, FMC TM1800, Superior	
Previous equipment used		
Containment System		
Type used now		
Vendor		
Previous equipment used		
Runoff treatment or recycling equipment		
Type used now	Natural pond control and treatment system	
Vendor	Vacuum swept product discharged under permit to city of Calgary sanitary sewer	
Previous equipment used		
Recyclability		
Operational Modification		
Changes made	Remove snow with brooms prior to de-icing Adjustable flow nozzles Manhole control inserts, less glycol enters drainage system	Use of E36 vs Urea
Gain		More environmentally friendly
Factors that were considered in selecting the above alternatives	Glycol use and subsequent treatment	Environmental impact of urea
Other alternatives considered	We will be installing a permanent sanitary sewer discharge.	
Testing done before or after implementation	Water management program determines sampling frequency	

	Aircraft	Runways
Impact of alternatives on operations (de-icing time, quality and maintenance)	No impact on de-icing activities	
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	Effluent is normally within BOD criteria for sanitary sewer	Using E36 reduces nitrates, ammonia: E36 consideration is acetate BOD
Problems implementing alternatives	No	No
Cost of alternatives compared to previous process	Some capital costs associated with infrastructure modifications	Costs E36 are four times higher
Material compatibility problems with alternatives	No	
How long have you used the alternative	1997	1995/96 season
Any additional information you feel should be stated here		

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS BWI-7

Baltimore\Washington International, Maryland Aviation Administration Contact: Mark Williams (410) 859-7448 Fax: (410) 859-7119

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Ethylene Glycol Type I + II 4% Propylene Glycol Type I + II 96%	Potassium acetate (P36) Urea
Vendor	Union carbide - Ethylene Arco-propylene	Cryotech (P36), Urea- varies
Amount of de-icing fluid used	Avg 217,000 gallons of mixture 94/95- 76,000 gal 95/96- 417,458 gal	94/95 95/96 P36 17,300 gal 56,000 gal urea 31.9 tons 107 tons
Previous chemical used	Shifted from ethylene glycol to mostly propylene glycol	UCAR Ethylene glycol-based de-icer Urea
Equipment		
Type used now	Performed by individual airlines and FBO's using "cherry picker" style de-icing trucks	Boom arm spray truck (P36) Vbox solid spreader truck for urea
Vendor	Various	Unknown
Previous equipment used	Same as above	Same
Containment System		
Type used now	Two centralized de-icing facilities designed by Greigner Engineering. Three Glycol recovery vehicles (GRV)	None
Vendor	GRV- Vector Manufacturing Inc.	
Previous equipment used	None	
Run-off Treatment or Recycling Equipment		
Type used now	Collect in a 600,000 gallon storage facility - discharge to sanitary; investigating recycling	none
Vendor		
Previous equipment used	none	
Recyclability		
Operational Modifications		
Changes made	U.S.Air/U.S.Air Express have shifted de-icing operations to centralized de-icing facilities. USAir operates 50% of passenger flights from BWI.	Switch to potassium acetate from UCAR
Gain		

	Aircraft	Runways
Factors that were considered in selecting the above alternatives	Location, size, space, operational requirements, cost, sited at end of runway 15R, which handles 72% of flights during de-icing operations.	Cost, availability, equipment requirements, de-icing results
Other alternatives considered	Recycling was considered but at the time was not considered cost effective	Application rates are controlled
Testing done before or after implementation	De-icing storm event water quality monitoring performed prior to management practices being installed. Required to perform study again with BMP's in place.	Would be seen in storm water monitoring. We don't test for potassium acetate.
Impact of alternatives on operations (de-icing time, quality and maintenance)	De-icing shifted to end of runway, less secondary de-icing. Five aircraft can be de-iced simultaneously.	
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	Six storm events monitored, it appears glycol levels and BOD decreased but TKN (total nitrogen) levels still high.	less glycol in runoff, should translate into lower BOD and toxicity.
Problems implementing alternatives	Yes, design problem in diversion vaults allowed water to enter dry chamber and damage valve controls.	No
Cost of alternatives compared to previous process	Cost $15 million Two de-icing facilities, storage facility, sewer connection, three Vactor glycol Recovery vehicules.	Not considerably different
Material compatibility problems with alternatives	No	No
How long have you used the alternative	One year	Three years
Any additional information you feel should be stated here		We may test sodium formate 96/97 and evaluate urea

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS VIA-8

Vancouver International Airport, Richmond, BC, Canada Contact: Laura Patrick (604) 276-6138 Fax: (604) 276-6699

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Glycol based	Urea
Vendor	Union carbide	
Amount of de-icing fluid used	55,000 litres	
Previous chemical used		
Equipment		
Type used now	Airline provide equipment	Spreaders
Vendor		
Previous equipment used		
Containment System		
Type used now	Trench drains diverted to ponds with liners and vacuum trucks	None
Vendor	Hudson General supplies vacuum trucks and operates them	
Previous equipment used		
Run-off Treatment or Recycling Equipment		
Type used now	All fluid trucked to sanitary plant with secondary treatment	None
Vendor		
Previous equipment used		
Recyclability	<30%	
Operational Modifications		
Changes made	Airlines experimenting with type II anti-icing	Airport looking at Potassium acetate for '97
Gain	Anti-icing	Anti-icing
Factors that were considered in selecting the above alternatives	Product effectiveness	Product effectiveness
Other alternatives considered	None	None
Testing done before or after implementation	Limited testing in 1995/96 winter	1996/97 tests
Impact of alternatives on operations (de-icing time, quality and maintenance)	Type II if used at the gate will save time	Unknown
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	Minimal	Not known
Problems implementing alternatives	Need new equipment	Need new equipment
Cost of alternatives compared to previous process	Unknown	Unknown

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	Aircraft	Runways
Material compatibility problems with alternatives	Yes	Yes
How long have you used the alternative	One season	Not yet
Any additional information you feel should be stated here	Airlines are responsible for application	

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS MTL-9

Montreal Mirabel and Dorval Airport Contact: Lyne Michaud (514) 633-3108 Fax: (514) 633-3708

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Ethylene Glycol	Urea
Vendor	Union Carbide	Stanchem
Amount of de-icing fluid used	Dorval 1.4 million liters Mirabel 0.9 million liters	500 tons, each airport
Previous chemical used		
Equipment		
Type used now	Mirabel: one Elephant Beta	
Vendor		
Previous equipment used	Std trucks	Regular spreader truck
Containment System		
Type used now	Mirabel: Centralized de-icing center, trenches to containment, fluid truck carried for outside disposition Dorval: Blocked drains in de-icing areas, vacuum truck pickup trapped fluid (will move toward centralized pads in the future)	
Vendor		
Previous equipment used	None	
Run-off Treatment or Recycling Equipment		
Type used now	Outside treatment, setting up recycling (remaining fluid after recycling will be sent to sanitary), will eventually take other surrounding smaller airports collected fluids for treatment	
Vendor		
Previous equipment used		
Recyclability		
Operational Modifications		
Changes made		
Gain		
Factors that were considered in selecting the above alternatives	Quality of water Operational (de-icing time)	
Other alternatives considered		Looking at potassium acetate
Testing done before or after implementation	Tested in use	

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	Aircraft	**Runways**
Impact of alternatives on operations (de-icing time, quality and maintenance)	Some problems where encountered, alternative areas where set-up for peek periods (central de-icing pads not enough), glycol recovery vehicules pick up fluids Elephant beta truck: enables to get closer to aircraft, less glycol used.	
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.		
Problems implementing alternatives	Minor	
Cost of alternatives compared to previous process	Built in airport in the '70s but started two years ago, no exact cost available	
Material compatibility problems with alternatives		
How long have you used the alternative	Two to three years	
Any additional information you feel should be stated here		

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AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS EAF-10

Ellsworth AFB, South Dakota Contact: Jerry Styles (Aircraft: Tsgt. Gary Vance, Runway: Mr. Grueschon)
J Styles (605) 385-2683 Fax: (605) 385-6619
Tsgt. Vance (605) 385-4441 Fax: (605) 385-4872
Mr. Gruschon (605) 385-4340 Fax: (605) 385-4375

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Milspec: MIL-A-8243D NSN: 6850-01-281-0339	Propylene Glycol, Isopropyl
Vendor		
Amount of de-icing fluid used	2839 gallons	2200 gallons
Previous chemical used	same	Isopropyl EC-36
Equipment		
Type used now	Air blast system-9 (NSN: 1730-01-333-4365) De-icing spray unit - II (NSN: 1730-01-200-0730)	Airblast system de-icing unit
Vendor		
Previous equipment used	Same	
Containment system		
Type used now	De-icing allowed in one area that drains to a collection pond with aerator	N/A
Vendor		
Previous equipment used	None	
Runoff treatment or recycling equipment		
Type used now	Collection pond with aerator	
Vendor		
Previous equipment used	None	
Recyclability	N/A	
Operational modifications		
Changes made	Only allow de-icing in one designated area	
Gain	Runoff limited to one collection pond, can contain and treat one pond	
Factors that were considered in selecting the above alternatives	The policy letter was considered to increase retention and exposure time before leaving base property	
Other alternatives considered	Replumb all drains to outfall 1, no capability to handle all drainage	
Testing done before or after implementation	DOD testing found high levels of BOD at ponds 2 and 3	

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	Aircraft	Runways
Impact of alternatives on operations (de-icing time, quality and maintenance)	Aircraft must be towed or prepositioned by dedicated de-icing areas	
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	BOD levels are much lower, from 1260 to 130	
Problems implementing alternatives		
Cost of alternatives compared to previous process	The previous process had no cost but new dedicated de-icing tanks with recycle capabilities cost $1,000,000	
Material compatibility problems with alternatives	No	
How long have you used the alternative	The policy letter was written Oct '95, alternative implemented shortly after.	
Any additional information you feel should be stated here	The dedicated de-icing tanks will let the chemicals be captured to be reused and recycled. Tanks will be placed at north and south ends of hammerhead project number FXBM963006	

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS DIA-11

Denver International Airport, CO. Contact: Myles Carter (303) 342-2628 Fax: (303) 342-2617

	Aircraft	Runways
Chemicals		
De/Anti-icing chemical(s) now used	Type I, Propylene glycol formulation	Potassium Acetate
Vendor	Various, but principally ARCO	Unknown
Amount of de-icing fluid used	800,000gal/yr	Unknown
Previous chemical used		Urea
Equipment		
Type used now	Ten stationary booms and 30+ truck boom units	Three to four trucks with spray booms
Vendor	A.D.S.I.	city
Previous equipment used	same	Broadcast spreaders on trucks
Containment System		
Type used now	Nine lined ponds at five locations	N/A
Vendor	N/A	N/A
Previous equipment used	One lined pond	N/A
Run-off Treatment or Recycling Equipment		
Type used now	Chemical conditioning followed by distillation	N/A
Vendor	ADSI	N/A
Previous equipment used	same	N/A
Recyclability	>70%	
Operational modifications		
Changes made	New airport and de-icing facilities	
Gain		
Factors that were considered in selecting the above alternatives	Outgrew old facility now is more environmental friendly	
Other alternatives considered	Considered pretreatment by aeration, also land application	
Testing done before or after implementation	Routinely test for COD to estimate BOD in waste stream	
Impact of alternatives on operations (de-icing time, quality and maintenance)	Disposal cost savings	
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	Ecologically compatible, possible cost savings	
Problems implementing alternatives	Initial capital costs to the city	
Cost of alternatives compared to previous process	Alternatives probably cost more	

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	Aircraft	Runways
Material compatibility problems with alternatives	No	
How long have you used the alternative	N/A	
Any additional information you feel should be stated here	No	

AIRCRAFT AND RUNWAY DE-ICING/ANTI-ICING CASE STUDY RESULTS WAF-12

Whiteman AFB, Missouri Contact: Maj Steven Smith (Aircraft) (816) 687-6101 Fax: (816) 687-6106
Jerry Whitford (Runway) (816) 687-6709 Fax: (816) 687-5164

	Aircraft	**Runways**
Chemicals		
De/Anti-icing chemical(s) now used	Propylene Glycol	Urea
Vendor	Purchased through Base Supply	Purchased under NSN 6810-00-182-6521/AA 259Q
Amount of de-icing fluid used	<500 gal	67,550 lbs in 1996
Previous chemical used		
Equipment		
Type used now	TM 1800 Landoll De-icers seven units	Six-Rollovers-Oshkosh Five-Multipurpose Plow/Blower - Oshkosh Two Towed snow broom - Sicard Three Front mount snow broom - International dump with Idaho & Sweepster broom Three 10-ton dump with plow-International Six 5-ton dump with plow and spreader - International
Vendor		
Previous equipment used		
Containment System		
Type used now	Diverter valve directs flow to Industrial Wastewater Treatment Plant	None
Vendor		
Previous equipment used	None	None
Run-off Treatment or Recycling Equipment		
Type used now	Same as item 3	None
Vendor		
Previous equipment used		
Recyclability		
Operational Modifications		
Changes made	Installation of diverter valve	Plan to use potassium acetate
Gain	Reduce quanitity of de-icing fluid going to the storm sewer	Reduce ammonia levels in streams due to runoff from urea:

200

	Aircraft	Runways
Factors that were considered in selecting the above alternatives	Stop flow of de-icing fluids to the storm sewer	Eliminate elevated ammonia levels in receiving streams
Other alternatives considered	None	Potassium Acetate
Testing done before or after implementation	None	None
Impact of alternatives on operations (de-icing time, quality and maintenance)	de-icing location inside secure area. De-ice one aircraft at a time.	N/A
Impact of alternatives on runoff BOD, nitrates, ammonia formation, ecological toxicity, or hazard levels.	Reduce chances of elevated BOD in receiving waters	N/A
Problems implementing alternatives	Physical operation of manual valve has been difficult	Purchase of equipment and storage pending
Cost of alternatives compared to previous process	Additional time for taking/towing aircraft and operating diverter valve	$132,000 (est.) to purchase equipment for using potassium acetate
Material compatibility problems with alternatives	No	No
How long have you used the alternative	Two years	Plan to begin use winter of 1996-1997
Any additional information you feel should be stated here		

Appendix 3

References

NDCEE

References

1. Exploring Available De-icing Technologies, Air Force Logistics Management Agency (ALFMA)
2. Draft Report on the requirements analysis for de-icing, Human Systems Center (HSC)
3. De-icing Chemicals (Web page, Pro-act site)/fact/text/6159.txt
4. Getting Ready for Winter, AEM November 1995
5. Exploring Available De-icing Technologies (Web page, Pro-act site)
6. De-icing Technologies, AFMC slides
7. First Full Demo for InfraTek, Airports International
8. AiRefrigeration Systems Inc, Jane's Airports, Equipment and Services 1995/1996
9. Technology Crossfeed on De-icing/Anti-icing slides, Carroll Herring
10. NDCEE De-icing Case Studies (1996)
11. Pollution Prevention Pillar Needs Assessment Report for FY 96. U.S. Air Force Environmental, Safety, Occupational Health Technology Needs Survey. Wright Laboratory, Wright-Patterson AFB, OH. July, 1996.

Briefing: De-icing / Anti-icing Technologies and Case Studies

Briefed by: **Brian Greene**
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Summary:

Regulatory compliance is driving the need for the US Air Force and commercial airlines and airports to identify and evaluate technologies for reducing the environmental impact of de-icing fluids.

Two recent Air Force reports provide analysis of de-icing needs and potential alternatives: "Report on the Requirements Analysis for De-icing" (Draft version dated June 28, 1996) by the Human Systems Center/XRE (HSC) of Brooks AFB, and "Exploring available De-icing Technologies" (October 1995) by the Air Force Logistics Management Agency (AFLMA).

This briefing summarizes the technologies identified in the two Air Force reports, and includes an independent analysis of the information in the reports by the National Defense Center for Environmental Excellence (NDCEE).

The briefing covers alternative technologies, materials, and operational procedures for both aircraft and runway de-icing.

In addition, the briefing includes a discussion of deicing case studies developed by the NDCEE through surveys of various airports, military bases, and airline companies. Information is included from these locations:

Detroit Metro Wayne Co. Airport
Detroit, Michigan
Contact: Catherine S. Morse
(313) 942-3996 Fax: (313) 942-0689

US Air & Pittsburgh International Airport
Pittsburgh, PA,
Contacts: Mike Athanas **(Aircraft)**
(412) 472-1690 Fax: (412) 472-1690
Brad Penrod **(Runways)**
(412) 472-3677 Fax: (412) 472-3636

Minneapolis-St. Paul International Airport
Minneapolis MN
Contact: Richard B. Keinz
(612) 726-8134 Fax: (612) 726-5296

Lester B. Pearson International
Toronto, Ontario, Canada
Contact: Randy McGill
(905) 676-5091 Fax: (905) 676-3555

Albany County
Albany, NY
Contact: Dave Logan, Ops Mgr.
(518) 869-5481 Fax: (518) 452-3330

Calgary Airport Authority
Calgary International Airport
Calgary, Alberta, Canada
Contact: Clark Norton
(403) 735-1405 Fax: (403) 735-1418

Baltimore\Washington International
Maryland Aviation Administration
Contact: Mark Williams
(410) 859-7448 Fax: (410) 859-7119

Vancouver International Airport
Richmond, BC, Canada
Contact: Laura Patrick
(604) 276-6138 Fax: (604) 276-6699

Montreal Mirabel and Dorval Airports
Montreal Quebec Canada
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(514) 633-3108 Fax: (514) 633-3708

Ellsworth AFB
South Dakota
Contact: Jerry Styles
(605) 385-2683 Fax: (605) 385-6619
Aircraft: TSgt. Gary Vance
(605) 385-4441 Fax: (605) 385-4872
Runway: Mr. Grueschon
(605) 385-4340 Fax: (605) 385-4375

Denver International Airport
Denver CO
Contact: Myles Carter
(303) 342-2628 Fax: (303) 342-2617

Whiteman AFB
Missouri
Contact: Maj. Steven Smith **(Aircraft)**
(816) 687-6101 Fax: (816) 687-6106
Jerry Whitford **(Runways)**
(816) 687-6709 Fax: (816) 687-5164

AIR FORCE BASIC RESEARCH:

CHEMISTRY FOR ENVIRONMENTALLY BENIGN DEICER/ANTI-ICER MATERIALS FOR HAZARD-FREE OPERATIONS AND MAINTENANCE (HFO&M)

Dr Frederick L. Hedberg
Directorate of Chemistry and Life Sciences
Air Force Office of Scientific Research
21 August 1996

ALTERNATIVE MATERIALS AND PROCESSES FOR HFO&M

RATIONALE:

- MATERIALS & PROCESSES CRITICAL TO AIR FORCE OPERATIONS & MAINTENANCE ARE BEING INCREASINGLY REGULATED DUE TO ASSOCIATED ENVIRONMENTAL HAZARDS

- SATISFACTORY PERFORMANCE, COST, AND COMPLIANCE WITH CONTEMPORARY SAFETY REQUIREMENTS ENCOURAGED THEIR USE FOR DECADES WITH LITTLE DRIVE FOR DEVELOPMENT OF ALTERNATIVES

ALTERNATIVE DEICER/ANTI-ICER MATERIALS FOR HFO&M

OBJECTIVE: A TECHNOLOGY BASE OF MECHANISTIC UNDERSTANDING AND MOLECULAR CONCEPTS FOR DEVELOPMENT OF SAFE ALTERNATIVES FOR AIR FORCE APPLICATIONS

AIR FORCE LAB COORDINATION:

AIRCRAFT DEICER/ANTI-ICER MATERIALS - AL/EQ, WL/ML

FUEL DEICER/ANTI-ICER MATERIALS - WL/PO

PROBLEMS WITH CURRENT DEICER/ANTI-ICER MATERIALS

AIRCRAFT DEICER/ANTI-ICER MATERIALS:

- ETHYLENE GLYCOL
  - TOXIC
  - HIGH BIOLOGICAL OXYGEN DEMAND (BOD)
- PROPYLENE GLYCOL
  - HIGHER BOD THAN ETHYLENE GLYCOL

FUEL DEICER/ANTI-ICER MATERIALS:

- ETHYLENE GLYCOL MONOMETHYL ETHER (EGME)
- ETHYLENE GLYCOL DIMETHYL ETHER (DIEGME)
  - TOXIC
  - SEPARATION FROM FUEL IN STORAGE TANKS

APPROACHES TO ALTERNATIVE AIRCRAFT DEICER/ANTI-ICER MATERIALS

- USE LESS MATERIAL!!
- BIOLOGICAL ANTIFREEZE PROTEINS THAT PREVENT CLOGGING OF BLOOD VESSELS - INHERENT NON-TOXICITY
  - MIMIC NATURE'S OPTIMIZATION OF MATERIALS
  - POLAR FISH - UNIV. OF ILLINOIS (PROF. CHENG-DEVRIES)
  - POLAR INSECTS - NOTRE DAME UNIV. (PROF. DUMAN)
  - FEEDS INFO TO LAB-SUPPORTED ASPEN SYSTEMS PROGRAM

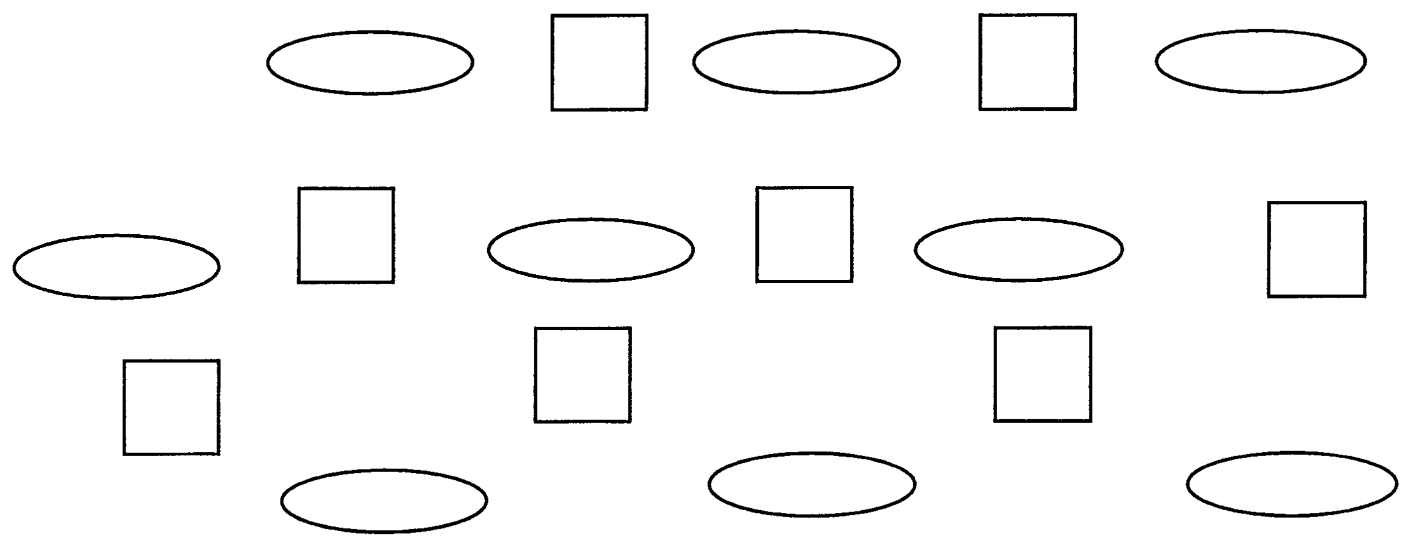
- SPECIALIZED EVERGREEN VEGETATION
  - DEVELOP BIOTIC ENVIRONMENT AROUND ROOT SYSTEMS TO DEGRADE CURRENT GLYCOL MATERIALS - IOWA STATE UNIVERSITY (PROFS. ANDERSON & COATS)

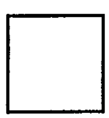
EFFECTIVENESS OF BIOLOGICAL DEICER/ANTI-ICER MATERIALS

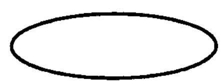
POTENTIAL TO USE MUCH LESS MATERIAL: A NEWLY PURIFIED, NON-ACTIVATED INSECT AFP HAS BEEN FOUND TO BE 167 TIMES MORE EFFECTIVE THAN ETHYLENE GLYCOL (NOTRE DAME UNIV. RESEARCH):

DEICER/ANTI-ICER MATERIAL / CONCENTRATION	WATER FREEZING POINT DEPRESSION (DEGREES C)
ETHYLENE GLYCOL / 1 MG/ML	0.03
INSECT AFP / 1 MG/ML	5 (167 TIMES GREATER)

"COLLIGATIVE" MECHANISM OF CONVENTIONAL DEICER/ANTI-ICER MATERIALS

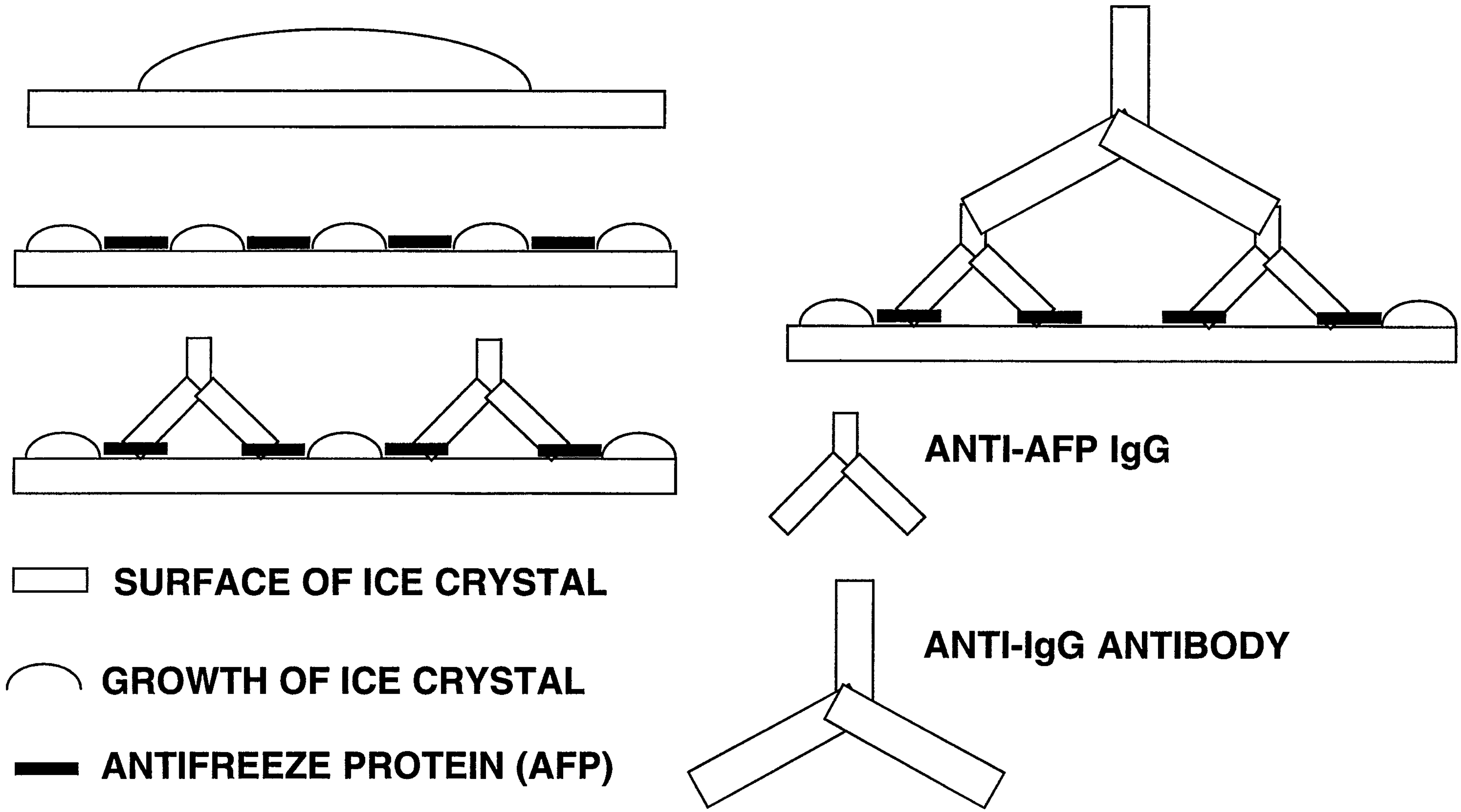


 = H_2O

 = ANTIFREEZE MOLECULE

ANTIFREEZE MOLECULE ASSOCIATES STRONGLY WITH WATER MOLECULES, INHIBITING THE WATER MOLECULES FROM ASSOCIATING WITH EACH OTHER TO FORM ICE CRYSTALS

POSTULATED "NON-COLLIGATIVE" MECHANISM FOR BIOLOGICAL DEICER/ANTI-ICER MATERIALS



BENEFITS FROM "NON-COLLIGATIVE" DEICER/ANTI-ICER MATERIALS

SURFACE RATHER THAN BULK MECHANISM WOULD ALLOW USE OF ORDERS OF MAGNITUDE LESS MATERIAL

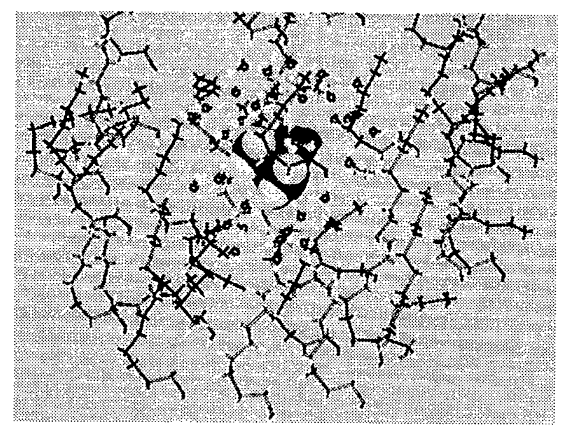
COMPUTATIONAL MODELING & SYNTHESIS TO DESIGN/PREPARE IMPROVED FUEL DEICERS/ANTI-ICER MATERIALS

INTEGRATED COMPUTATIONAL MODELING (WL/ML - DR PACHTER) & SYNTHESIS (GEORGE MASON UNIV. - PROF. MUSHRUSH) PROGRAMS SEEK MORE EFFICIENT MOLECULAR DESIGN AND LOWER TOXICITY

- Calculate partition coefficients
- Predict toxicities
- Predict phase diagrams & investigate de-icing mechanisms
- Guide specific synthesis

MOST PROMISING TO DATE:

TARGETS BIOLOGICALLY-BASED MOLECULES



REQUIRES MISCIBILITY WITH FUEL

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Briefing: Air Force Basic Research in Deicer/Anti-icer Chemistry

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Air Force Office of Scientific Research (AFOSR)
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Summary:

The Air Force Office of Scientific Research is currently supporting basic research programs relating to deicer/anti-icer chemistry as a key component of its thrust on alternative materials and processes for hazard free operations and maintenance.

Conventional deicers/anti-icers are good examples of materials that have been used for many years because they are inexpensive and effective. In contrast to expensive, high performance materials for structural or electronic applications where improved performance is a continuing motivation for new materials, there has been very little motivation for R&D expenditures for a tech base for new deicers/anti-icer materials. Because of recent and growing environmental regulations, the standard materials: ethylene glycol and propylene glycol for aircraft deicers and ethylene glycol monomethyl and dimethyl ethers for fuel deicers face increasingly costly use restrictions or complete elimination.

The objectives of the AFOSR research efforts are a better understanding of the deicer chemistry and novel directions toward improved molecular concepts. The work is coordinated with the Air Force Armstrong Lab (aircraft deicers) and with the Wright Lab (fuel deicers). The fundamental concepts obtained are proving to be applicable to both types.

Problems identified for current aircraft deicer/anti-icer materials include toxicity and biological oxygen demand for ethylene glycol, and biological oxygen demand for propylene glycol. Problems identified for current fuel deicer/anti-icer materials, ethylene glycol monomethyl and dimethyl ethers, include separation from the fuel in storage tanks to provide a toxic waste.

The primary approach to overcoming this problem is new chemical concepts that require much less material. To accomplish this, researchers are looking at Nature, the great economizer. Organisms that live in polar environments manufacture minimal amounts of antifreeze agents to inhibit formation of ice particles that could clog blood vessels. These are large biological molecules that are obviously not toxic to the organism. A program funded at the University of Illinois is looking at fish antifreeze agents, and one at Notre Dame University is studying insect antifreeze agents. These programs provide fundamental technical information to a program at Aspen Systems that has been funded by

both Armstrong Lab and Wright Lab. An alternative approach, carried out at Iowa State University, is a study of evergreen plants that could be grown around airfields with biotic root systems that could degrade existing glycol materials.

The potential to use much less material is illustrated by a recently isolated insect antifreeze protein that is 167 times more effective than ethylene glycol.

Conventional agents such as glycols or salts are postulated to utilize a so-called colligative mechanism whereby the agent distributes itself evenly throughout the water, coordinates with the water, and provides an energy barrier to the water molecules coming together into an ice crystal. This bulk type mechanism requires substantial material.

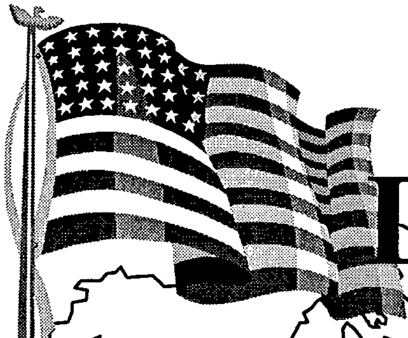
By contrast, the biological agents are postulated to allow ice crystals to grow to a nanoscale size. At this point, it becomes energetically favorable for them to attach to the crystal in a lock and key arrangement and inhibit further addition of water to the crystal. An even greater inhibition to crystal growth has been found to result from the presence of antibodies to the protein such as immunoglobulin G, and even antibodies to the immunoglobulin G antibodies.

The "non-colligative" mechanism postulated for the biological molecules affords the potential for use of orders of magnitude less material.

Fuel deicer/anti-icer materials have an additional requirement beyond that for the aircraft materials: in addition to inhibiting freezing of water unavoidably present in fuel, they must also be miscible with the fuel. The approach in this effort has been design of biologically-based molecules through computational modeling for antifreeze capabilities and low toxicity by a group at Wright Laboratory in conjunction with synthesis by researchers at George Mason University. The optimum materials will transition into a formulation and testing program at the Propulsion Directorate of Wright Laboratory. In addition to identifying new materials, the modeling may also identify promising commercially available materials manufactured for completely different applications that would otherwise not ever be considered for deicer/anti-icer applications.

One of the most intriguing possibilities to derive from the fuel deicer/anti-icer modeling effort is an indication that so-called colligative materials like the glycols may actually operate by the same mechanism as the large biological materials. It appears that clusters of six or seven water molecules form and are surrounded by ethylene glycol molecules. Whether this is an optimum size "crystal" for the ethylene glycol to fit on the surface in a lock and key arrangement analogous to the antifreeze proteins needs to be verified by further studies such as nuclear magnetic resonance.

Note: Dr. Hedberg is retiring from the federal civil service. His replacement will be Dr. Walt Kozumbo.



Deicing/Anti-Icing R&D Program at Wright Laboratory (WL)

2Lt. Ita Udo-Aka

AF pollution Prevention R&D Office

Materials Directorate

AF Deicing Technology Crossfeed
20-21 August 96
ANSER

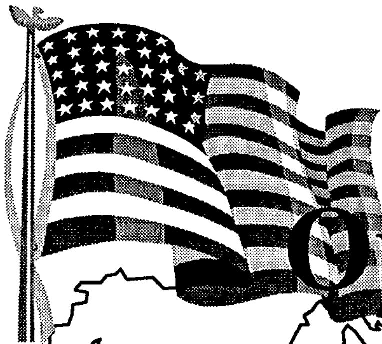
WL/MLSE
DSN 785-3929
(513) 255-3929

Overview

* Identification of Deicing/Anti-Icing Technology Needs
* Operational Requirements
* On-going Projects
* Related Programs
* Latest Development
* Summary

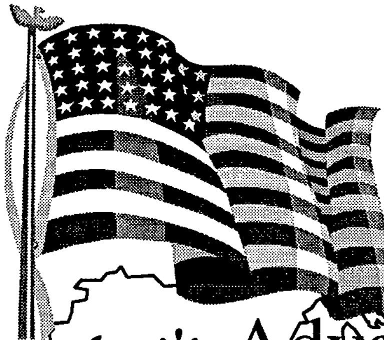
Identification of De-Icing/Anti-Icing Technology Needs

- ID 914: Environmental Improvements to Aircraft De-icing Operations
- ID 918: Improvements to Road De-icing Operations
- ID 2501: Use of Sodium Formate for the De-icing of Pavements
- ID 2504: Degradation Rates and Products for De-icing Compounds



Operational Requirements

- Air Mobility Command (AMC) is concerned with aircraft de-icing T.Os and safety
  - – AMC requests assistance from WL/ML in qualifying AMS 1428 (anti-icers) for AF use during 96/97 snow season
- Air Combat Command is also reviewing aircraft T.Os, practices, and problems

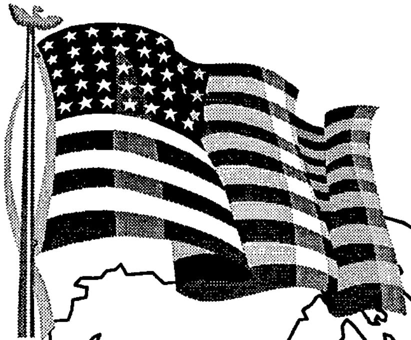


On-going Projects

- Advanced Aircraft Anti-Icer Program with NASA (Need ID 914)
  - 3 year effort with NASA Ames (FY93-FY95)
  - FY96:
    - 3M commercializing/qualifying anti-icer to meet AMS 1428
    - WL/ML performing material compatibility tests on AMS 1428 for AF Use
  - Goal: To qualify anti-icers for AF Use in the 96-97 snow season

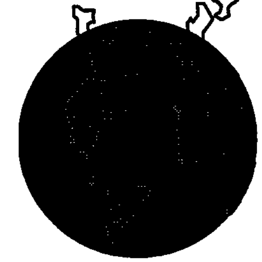
On-going Projects (continued)

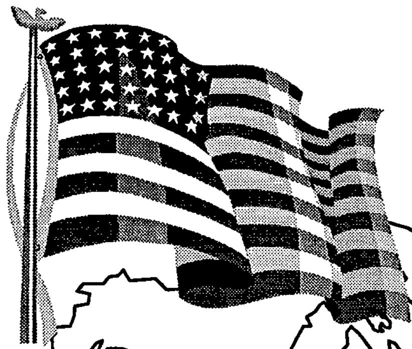
* Environmental Impact Study of Glycols in Groundwater (6/95-6/96) (Need ID 2504)
* Reviewing request from the field to conduct airframe-specific compatibility tests on AMS 1428 anti-icers
* Forced air de-icer program with FMC Corporation



Related Programs

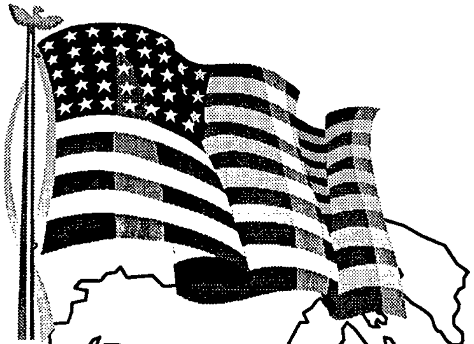
- WL/ML, WL/PO - Non-glycol Fuel Systems Ice Inhibitor Program (FSII)
- US Army Roadway De-icing Project
- US Navy review of aircraft de-icing T.Os and training/certification requirements
- European Community is a potential source of alternative de-icing technologies





Latest Development

- WL/MLS concluded material compatibility tests in June on commercial Type II anti-icers meeting the AMS 1428 specification
- All tests conducted produced satisfactory results
- AMS 1428 (Type II anti-icers) has been adopted for AF use in the 96-97 snow season



Summary

- Current on-going projects at WL will be completed by the end of this fiscal year
- Potential solutions to our de-icing problems are immediate, site-specific solutions rather than R&D solutions
- WL/ML will now play a consulting role in this arena while retaining membership in various deicing/anti-icing related organizations

AMES
ENVIRONMENT FRIENDLY
ANTI-ICING / DEICING
FLUID

BY

LEN HASLIM
JOHN ZUK

BASIC FORMULATION

- Freezing Point Depressant - Propylene Glycol
- Carrier - Water
- Thickener - Patent Proprietary
- Synergist - Patent Proprietary
- Coloring Agent (if needed)

ATTRIBUTES

- Simple True-Solution
- Food-grade Ingredients
- Non-toxic
- Biodegradeable
- Non-electrolytic / Chemically Neutral
- Highly Effective
  - Applications Tailorable
- Long Shelf Life
- Easy to Manufacture
- Recyclable
- Current Equipement Compatible
  - Modify Nozzle

KEY TEST RESULTS

- Passed Major SAE Type IV A/C Fluid Certification Tests
  - Holdover Time (113 Min.)
  - Aerodynamic Shedding (all Temperatures)
  - High Humidity Endurance (> 13 Hours)
  - Corrosion Resistance
- Verified More-Environment-Friendly Claims (U of PA)

STATUS / PLANS

- Transfer & Commericalize Technology
  - Aircraft Type IV Fluid
- Support U.S. Army Corps of Engrs Construction Productivity Advanced Research (CPAR) Program
  - Roads, Bridges, Canals
- Demonstrate Use on Airport Runways
  - Friction (FAA)
  - Effectiveness (NASA/FAA/Transport Canada)
- Continue Air Force Cooperative Program
  - Environmental Testing (U. of Pa)
  - Corrosion Testing (Wright Lab)
  - Support Future A.F. Runway Evaluations

Ames Fluid
Comparison with Ultra

- Higher Apparent Viscosity
- Better Shear Rate Behavior (Less Temperature Sensitivity)
- Simpler Fluid - Thickener & Precipitation Resistance Surface Modifier are in True Solution (No Mineral Oil Micro-emulsifier).
- No Long Term Storage Degradation - Under Freezing Conditions
- Non-toxic Freezing Point Depressent & Additives

NASA AMES
ENVIRONMENT-FRIENDLY ANTI-ICING FLUID

NASA Ames has invented a highly effective and non-toxic, non-electrolytic, freezing point depressant (FPD) fluid for use in ice removal and/or for protection against ice formation (anti-freeze). Ice formation and adhesion is prevented by applying (e.g. spraying) this fluid as a thin coating onto a surface where it adheres and forms a protective barrier to ice accretion. This fluid coating strongly resists removal by precipatation (also dilution) and surface winds. The fluid is designed so that it can be applied to aircraft, runway, roadway, bridge, and has automotive and marine uses. Compared to currently used commerical fluids, the new Ames version performs more effectively, is inherently less corrosive, and has minimum adverse effects on the environment. (Currently used fluids are toxic to aquatic life, animals and humans due to the freezing point depressant (such as ethylene glycol) and the additives (Reference 1).) Further, this formulation can be directly substituted for the currently used fluids, so that little or no change in operations or equipment is anticipated (a different nozzle may be required). US and international patent applications have been filed by NASA. The US patent award is anticapated in CY96. Development and evaluation work has been sponsored by the US Air Force's Wright Labs. A license to commericalize the fluid is being presently negotiated.

The composition consists of water, propolyene glycol as the freezing point depressant, a synergist, and a select thickener (all of which may be food grade), with all constituents in a continuous, single phase solution. The small amount of thickener (0.25 - 0.70 wt. %) radically changes the fluid from Newtonian to a Non-Newtonian pseudoplastic behavior, i.e., an Ellis-type fluid. When a thin film of the fluid (0.02 in. thick) is sprayed onto the surface of an object, this fluid film has a very high static (at rest) viscosity (one or two orders of magnitude higher than the currently used anti-icing fluids); and when sheared, the viscosity rapidly drops. Thus, the high static viscosity produces a fluid protective barrier to ice accretion that is very durable and long lasting as an anti-icer. The rapid viscosity drop induced by an increase in shear rate is a desirable feature that both enables ease of fluid application and uniformity of distribution and enables critical airspeed shedding, as required by aircraft

ground deicing applications. (The fluid must shed from the aircraft surfaces at lift-off to ensure clean lifting surfaces.)

Since all constituents can be food grade, the fluid is essentially non-toxic and is biodegradeable under normal atmospheric temperature, soil, and aquatic conditions. Also, since the fluid is inherently neutral (pH of 7) and non-electrolytic, it should not be corrosive to surface materials, such as aircraft, pavements, bridges, and ground vehicles. It should not be harmful to plants. Additional attributes of the fluid are that it 's viscosity - shear rate behavior has relatively low temperature sensitivity in the range of practical applications, and is not prone to being damaged due to mechanical shearing (pumping) as are other Type II fluids. The fluid is recyclable. Since the fluid ingredients can be simply blended, the manufacturing costs should be low. Also, the continuous, single-phase solution yields long, stable, storage life.

The initial fluid application being evaluated is for use as anti-icing protection of aircraft prior to take-off, and is being pursued in consort with a potential commericalization licensee. Presently used aircraft anti-icing fluids are governed by SAE Spec AMS 1428 and are known as Type II fluids. The current Type II specification requires a minimum 30 minutes holdover time (HOT) protection, as measured at the official certification facility at the University of Quebec at Cheicoutimi. Certification testing of the Ames fluid yielded the following results: 1) holdover time of 113 minutes, and 2) high humidity endurance time (HHET) > 13 hours. These results exceed the new SAE Type IV spec (which is in process of being approved) requirement of 90 minutes HOT, and 8 hours (HHET). The Ames fluid has also passed the very important aerodynamic shedding criteria test. (This test simulates an aircraft wing taking-off.) Critical corrosion resistance tests were also passed at another SAE certified facility - Scientific Material International Inc. (SMI) of Miami, FL. The Ames fluid will probably have to meet the proposed Type IV spec, currently known as SAE 1428B. (SAE1428A is the first Type IV fluid spec and the one that Union Carbide's Ultra[R] fluid must meet - Ultra[R]'s freezing point depressant is toxic eythelene glycol.) In addition to meeting the SAE spec, the fluid must also be acceptible to the customer including such subjective areas such as dryout and "slipperiness".

The University of Pennsylvania, has performed laboratory investigations assessing the environmental compatibility and

biodegradability of the Ames fluid and other commercially available fluids (Reference 2). In addition to characterizing the fluids in terms of their environmental implications, the biodegradability of the fluids were assessed under experimental conditions that simulated surface water and subsurface environments. The university's work verified that the Ames fluid was more environmentally benign than the other fluids tested, and was determined by measured specific oxygen uptake rate (SOUR) and EC_{50} values. However, as expected with all glycol based fluids, the Biological Oxygen Demand (BOD) did yield high values. Hence the rapid exertion of BOD at the early stages would have profound impact on the oxygen inventory of a receiving water body in the vicinity of the point of discharge, that would be detrimental to aquatic life and higher than average sewage treatment plant capabilities. But more significantly, among the fluids tested, the Ames fluid was most easily degraded under both anoxic and anaerobic conditions. The Ames fluid had an *order of magnitude higher rate of biodegradation* under anaerobic conditions than any of the other commercial fluids tested.

Since the Ames fluid is readily biodegradable, it has a high BOD, as described in the previous paragraph. For effective deicing under severe icing conditions, a large volume of fluid is required per aircraft - 400 to 1000 gallons of diluted fluid depending on aircraft size. Hence, deicing/anti-icing a large number of aircraft will result in a large volume of fluid concentrated in a relatively small area (dedicated pad or gate area). Even athough the Ames fluid is non-toxic and diluted, the BOD may have a negative impact on aquatic life at the discharge point. Hence, a drainage capture system may be needed. The collected fluid can then be recycled or treated by promising methods such as high rate anaerobic treatment. However, once the aircraft leaves the deicing containment area, there still remains the environmental runoff concerns in the proximity of the airport. The non-toxic Ames fluid offers promise to have minimal or no adverse impact on this environment.

This winter the FAA Technical Center plans to evaluate the effectiveness of the fluid for runway applications at the Brunswick Naval Air Station airport in Maine. The main purpose of the test is to evaluate the Ames anti-icing fluid for tire friction or "slipperiness". The FAA Boeing 727 Instrumented aircraft will be used to measure the runway friction coefficient. (This is the only aircraft in the world instrumented to give friction readings.) Also the KJ Law Runway Friction Tester - a ground vehicle, will measure the friction

coefficient. Results will be compared with both dry and water wet runway pavement readings. The Ames fluid data then will be compared with previously obtained measurements using conventional runway deicing liquid and solid materials, as well as other experimental materials. Later in the winter of 1997, a runway anti-icing effectiveness test may be conducted at Thunder Bay, Ontario as part of the Transport Canada, NASA, and FAA winter operations research program. These results will also directly support the Wright Labs runway icing protection efforts.

The Army Corps of Engineers' Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire has implemented a Construction and Productivity And Research program (CPAR) to evaluate the Ames fluid for terrestrial applications. These applications include highways, bridges, railways, canals, and transportation and communication structures. This three year program also includes a commercialization partner, and the University of Pennsylvania, with particapation from the City of Philadelphia. The University of Penn. will measure friction factors using a lab device to assure compliance with standards and to validate field tests conducted under the auspices of the Corps of Engineers. Compatibility and stability tests will be conducted on a wide range of materials that are found on aircraft, automobiles, and transportation surfaces, and under a variety of weather conditions. Then tests will be performed to measure pavement friction using a SAAB friction tester vehicle on a test track. Comparison tests will be run against existing (corrosive - salts) deicing materials such as calcium magnesium acetate. If these tests are successful, the fluid will be evaluated on a highway test strip.

To date the cooperative program with the Air Force has been critical to the success. In the future, Ames will support Wright Labs corrosion testing and any Air Force ice protected runway evaluations. Also, it is anticipataed that the expertise and testing capability of Armstrong Labs in the area of toxicity will be utilized.

In summary, the Ames anti-icing fluid improves safety, is cost effective, and helps the environment by both being relatively non-toxic and requiring less fluid per application than those currently being used.

References

1. Hartwell, S.I. et al.: "Toxicity of Aircraft De-Icer and Anti-Icer Solutions to Aquatic Organisims", Maryland Dept. of Natural Resources Report No. CBRM-TX-93-1, May 1993.

2. Shieh, W. K.: "Task 009-3: Environmental Compatibility Study of Deicing/Anti-icing Fluids", University of Pennsylvania Final Report, Contract F33615-194-C-5800, June 1996.

NASA'S ENVIRONMENTALLY FRIENDLY ANTI-ICING FLUID

Researchers at NASA Ames Research Center have invented a highly effective, non-toxic, non-electrolytic, freezing point depressant (FPD) fluid for ice removal (de-ice) and/or protection against ice formation (anti-ice). Ice formation and adhesion is prevented by spraying the fluid as a thin coating onto a surface where it adheres and forms a protective barrier to ice accretion. This fluid coating strongly resists removal by surface winds and removal/dilution by precipatation. The fluid can be applied to aircraft, runways, roadways and bridges, and has other automotive and marine uses. It not only outperforms current commerical fluids, it is inherently less corrosive, and has minimum adverse effects on the environment. (Commercially available fluids are corrosive, toxic to acquatic life, animals, and humans and do not meet Clean Water Act criteria.) Further, this formulation can be directly substituted for the currently used fluids, so that little or no change in operations or equipment is anticipated. (A different spray nozzle may be required on some equipment.)

US Air Force Wright Laboratory has sponsored development and evaluation work and has been instrumental in readying the fluid for commercialization. US and international patent applications have been filed by NASA. The US patent award is anticapated in CY96. Negotiations are underway with a Fortune 500 chemical company to manufacturer the Ames fluid under license.

The composition consists of water, freezing point depressant, hydrophobic surface modifier, and a select thickener in a continuous, single phase solution. Since all constituents are food grade, the fluid is essentially non-toxic and is biodegradeable under normal atmospheric temperature, soil, and aquatic conditions. The fluid is inherently neutral (pH of 7) and is not corrosive to surface materials such as bridges, pavements and automobiles, and it is not harmful to plants. The continuous, single phase solution yields long, stable storage life. A minute amount (0.5 wt %) of surface modifier additive forms a thin hydrophobic monolayer on the surface of the fluid applied to the structure. A small amount of thickener (0.25 - 0.70 wt. %) radically changes the fluid from Newtonian to a Non-Newtonian pseudoplastic flow behavior, i.e. an Ellis fluid. When a thin film of the fluid (0.02 in.) is sprayed onto the surface of an object, the film has a very high near-static viscosity, one or two orders of magnitude higher than current fluids, but when a predetermined shear point is reached, the viscosity drops rapidly. The static viscosity produces a very durable and long lasting anti-icing barrier, while the rapid viscosity drop induced by an increase in shear force eases application and ensures uniform coverage. This tailorable property also allows critical speed shedding, as required in aircraft applications where the fluid must shed from the wing surface before lift-off.

Current SAE AMS 1428 Type II specifications require a minimum 30 minutes holdover time protection measured at the official certification facility at the University of Quebec at Cheicoutimi. In these tests the Ames fluid set two new records: 1) a holdover time of 113 minutes, and 2) a high humidity endurance time over 13 hours. Hence, this fluid already exceeds the newly proposed SAE *Type IV* spec requirement of 90 minutes. The fluid also passed the aerodynamic shedding criteria test (simulating an aircraft wing in takeoff conditions) with no remaining undesirable residue. Critical corrosion resistance tests were also passed at another SAE certified facility, Scientific Material International Inc., Miami, FL. A major commercial company is in the process of making minor modifications to the fluid formulation to meet thermal, hard water, and air stability tests. The Ames fluid, being non-toxic, biodegradable and more effective than any existing de-icing/anti-icing fluid, is a quantum jump in safety and environmental compatability.

For the rest of the story and additional data, contact:
Dr. John Zuk, NASA-Ames Research Center, Ph. 415-604-6568
Dr. Len Haslim, NASA-Ames Research Center, Ph. 415-604-6575
Lt Col Rich Perkins, USAF-NASA Liaison Office, Ph. 415-604-5832

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RISK ASSESSMENT OF HAZARDOUS MATERIALS: THE ROLE OF TOXICOLOGY

David R. Mattie, PhD, DABT

Branch Chief/Director of Program Development

Toxicology Division

Armstrong Laboratory

AIR FORCE TOXICOLOGY

EXPOSURE ASSESSMENT

Identify Potential Exposure

Determine Exposure Level & Duration

Collect Available Tox Data; Determine Deficiencies

HAZARD ASSESSMENT

Perform Additional Toxicity Testing As Needed

Investigate Biochemical Mode of Action

Develop Methods For Extrapolation,
Animals → Humans
High Dose → Low Dose

RISK ASSESSMENT

Risk Characterization

AF System Requirements and Options

Development Of Regulatory And Operational Guidelines

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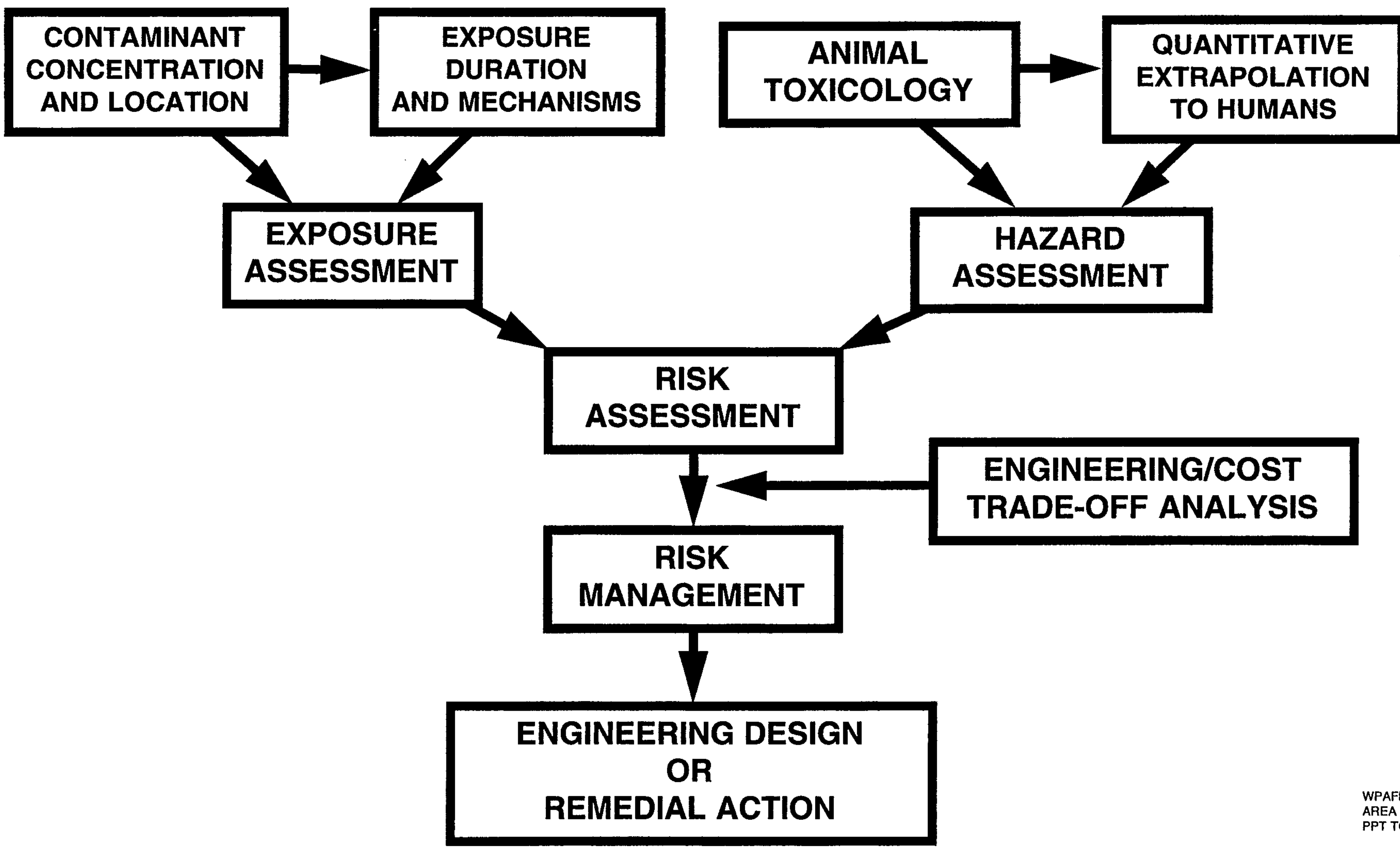
RISK MANAGEMENT



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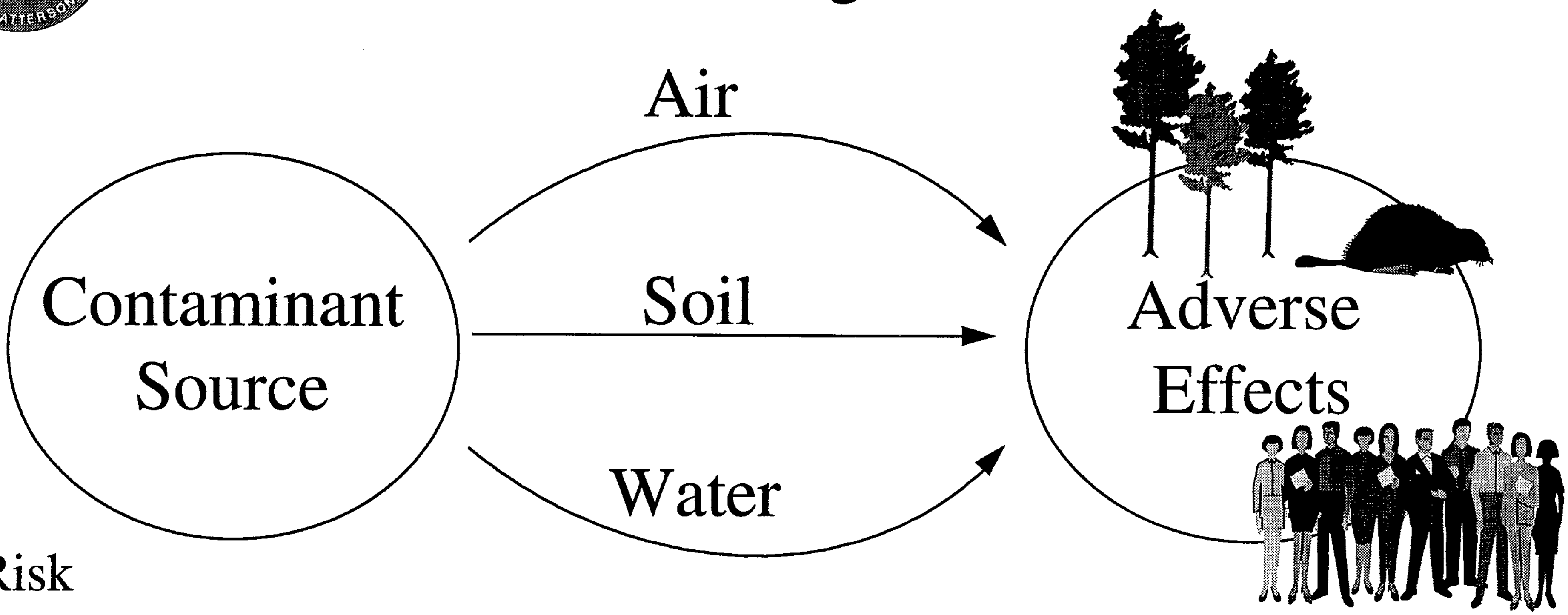
Conceptualized Risk-Based Model For Armstrong Lab



Risk Assessment:	Characterize (Sensors)	Fate and Transport (Modeling/Measurement)	Toxicology
Risk Management	Monitor (Sensors)	Bio/Physical/Chemical (Reduction)	Protection (PPE, Eng Cont, Exposure Limits)

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HEALTH-BASED APPROACH

- NEED DATA:
  - IN ABSENCE OF DATA USE ASSUMPTIONS, ADDITIONAL SAFETY FACTORS AND BEST SCIENTIFIC(?) JUDGMENT
  - WITH LIMITED DATA USE MOST CONSERVATIVE APPROACH
- WITH DATA:
  - GREATER CONFIDENCE IN STANDARDS CHOSEN
  - REALISTIC STANDARDS RESULTING IN LESS PPE, ENGINEERING CONTROLS OR LOWER CLEAN-UP COSTS FOR RESTORATION EFFORTS

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RISK ASSESSMENT

- Helps Choose Chemical/Material With Lowest Toxicity, When Possible, Without Decreasing Performance

- Anything Is Toxic In Too Large A Quantity. Risk Assessment Identifies The Toxic Level So The Chemical Or Material May Still Be Used While Avoiding Adverse Effects

AIR FORCE MATERIEL COMMAND (AFMC/ST) TECHNOLOGY PROGRAM DIRECTIVE 30-6-92

- Acquisition Instructions Outline The Need To Characterize Materials For Life Cycle Environmental, Safety And Occupational Health Management

- Program Managers Must Complete Hazardous Materials Risk Management Analysis As Part Of The Integrated Program Summary At Each Milestone Review

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HEALTH BASED APPROACH

- ENVIRONMENTAL:
  - CLEAN-UP STANDARDS
  - EXAMPLE: TOTAL PETROLEUM HYDROCARBON

TRI-SERVICE TOXICOLOGY

- COLLOCATION OF TOXICOLOGY FUNCTIONS FOR 3 MILITARY SERVICES

- USAF - TOXICOLOGY DIVISION
ARMSTRONG LABORATORY
HUMAN SYSTEMS CENTER
(OL AL HSC/OET)

- USN - TOXICOLOGY DETACHMENT
NAVAL MEDICAL RESEARCH INSTITUTE
(NMRI/TD)

- USA - ARMY MEDICAL RESEARCH DETACHMENT
WALTER REED ARMY
INSTITUTE OF RESEARCH
(USAMRD)

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MISSION

We provide the Department of Defense and other customers with timely solutions to current and anticipated operational problems through an integrated approach to innovative human health effects toxicology research.

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GOALS

- Minimize the health risks and mission impact from exposures to hazardous chemicals encountered by Department of Defense personnel;

- Reduce the adverse environmental consequences of the use and disposal of hazardous materials by the Department of Defense; and

- Significantly decrease the life cycle costs required to protect human health and the environment.

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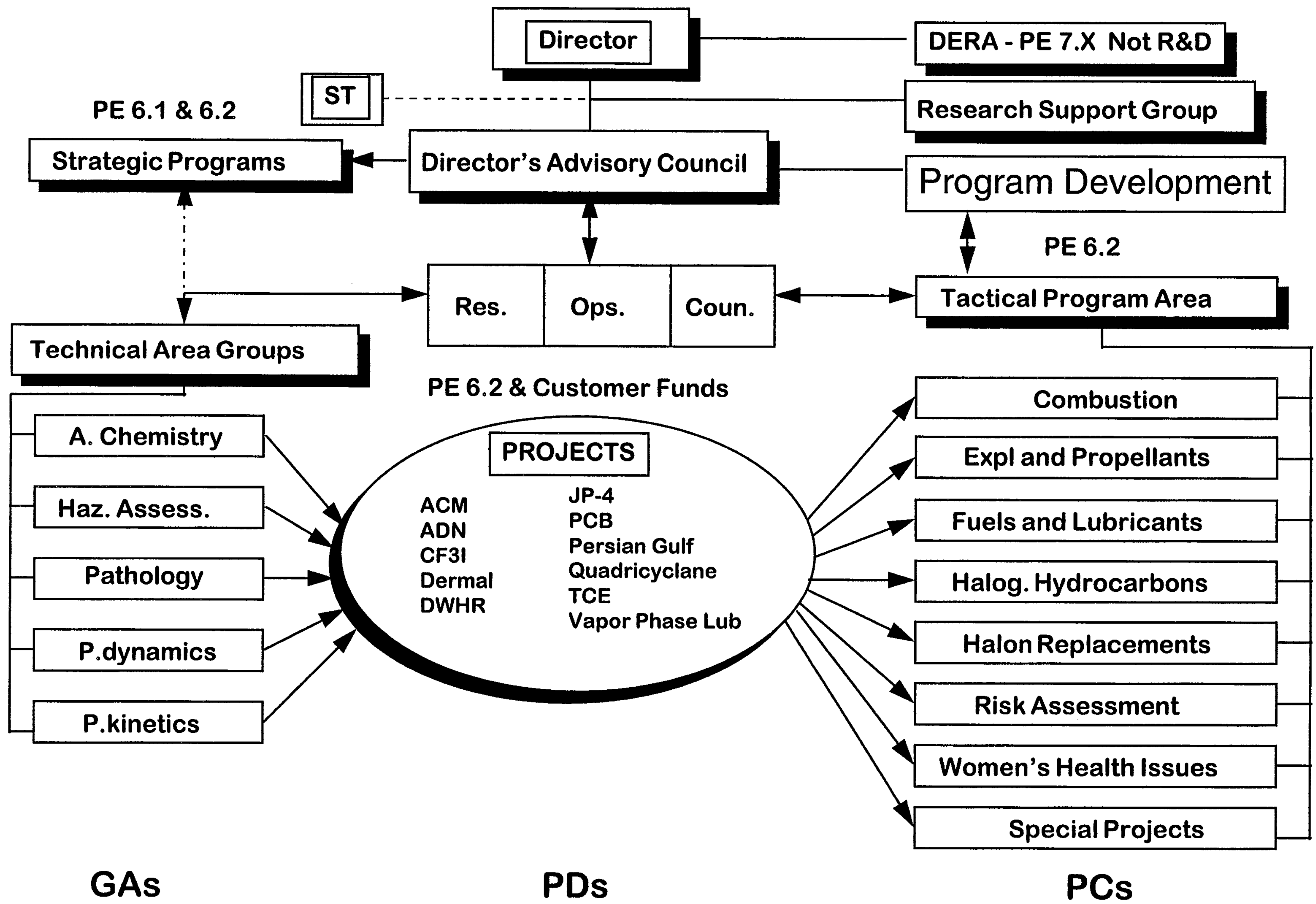

Director
DERA - PE 7.X Not R&D
ST
Research Support Group
PE 6.1 & 6.2
Strategic Programs
Director's Advisory Council
Program Development
PE 6.2
Res.
Ops.
Coun.
Tactical Program Area
Technical Area Groups
PE 6.2 & Customer Funds
A. Chemistry
Haz. Assess.
Pathology
P.dynamics
P.kinetics
PROJECTS
ACM
ADN
CF3I
Dermal
DWHR
JP-4
PCB
Persian Gulf
Quadricyclane
TCE
Vapor Phase Lub
Combustion
Expl and Propellants
Fuels and Lubricants
Halog. Hydrocarbons
Halon Replacements
Risk Assessment
Women's Health Issues
Special Projects
GAs
PDs
PCs

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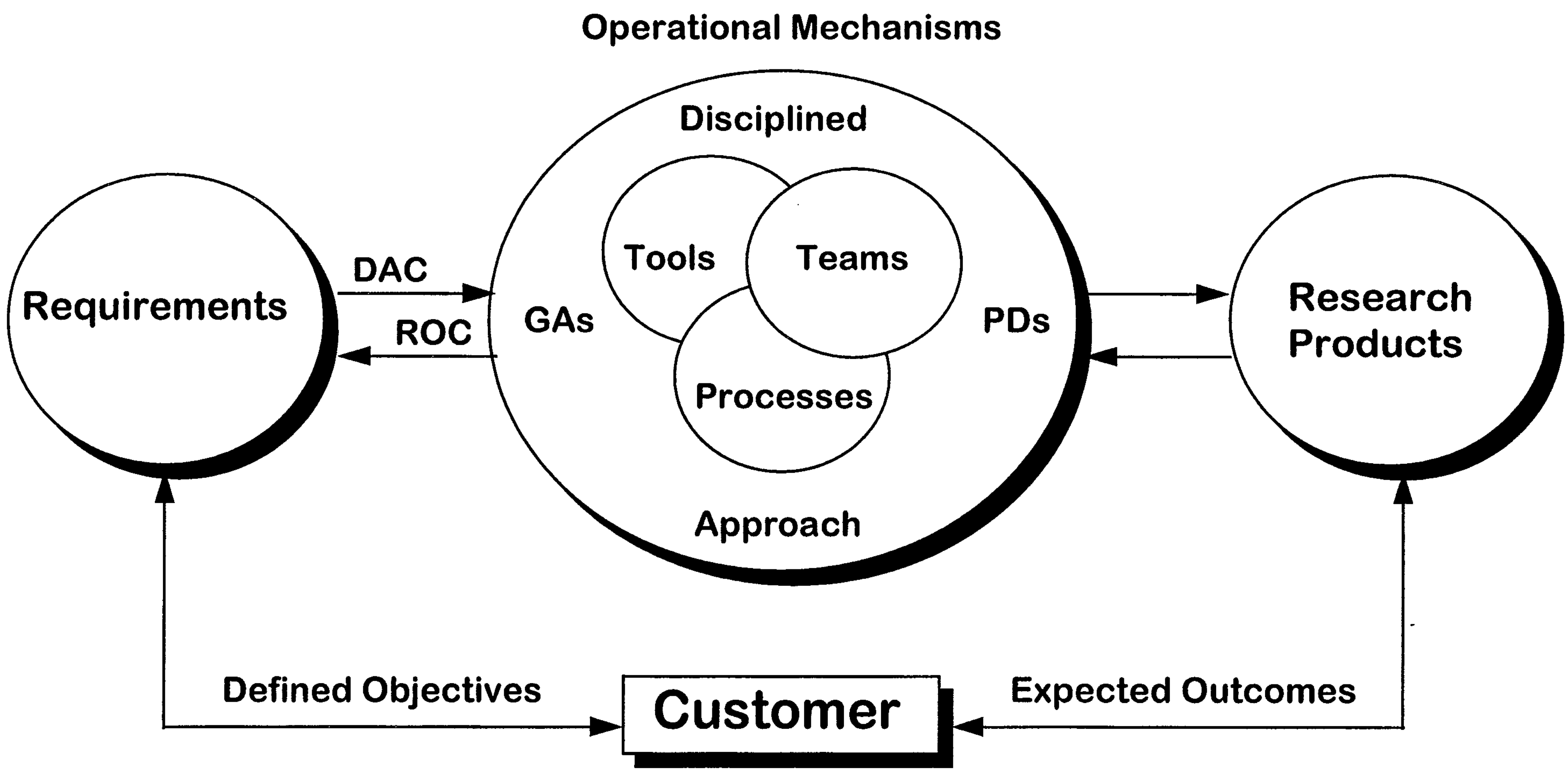
AFMC Model
Integrated Product Process Development
a.k.a "AF Teaming"



TRI-SERVICE CAPABILITIES

- HAZARD EVALUATION
- PHARMACOKINETICS
- MECHANISMS OF ACTION
- PATHOLOGY
- ANALYTICAL CHEMISTRY
- RISK ASSESSMENT

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PPT TOXIC

TRI-SERVICE CAPABILITIES

- IDENTIFIES POTENTIAL HUMAN HEALTH HAZARDS OF NEW AND CURRENT CHEMICALS AND MATERIALS.
- DEVELOPS INNOVATIVE RISK ASSESSMENT METHODOLOGIES.
- INVESTIGATES MECHANISMS OF TOXICITY.

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PROJECTS

- HALON REPLACEMENT
- ADVANCED COMPOSITE COMBUSTION TOXICOLOGY
- MODULAR ARTILLERY CHARGE
- PERSIAN GULF VETERANS' RESEARCH PROGRAM
- BIOLOGICAL EFFECTS OF TRICHLOROETHYLENE (TCE)
- METABOLISM OF TCE BY THE JAPANESE MEDAKA MINNOW
- INHALATION TOXICITY OF VAPOR PHASE LUBRICANTS
- DEFENSE WOMEN'S HEALTH RESEARCH PROGRAM
- ACUTE, SUBCHRONIC & REPRODUCTIVETOXICITY OF QUADRICYCLANE
- PREDICTIVE TOXICOLOGY
- QUANT. APPROACHES TO MEASURE & MODEL DERMAL PENETRATION
- TOTAL PETROLEUM HYDROCARBON (TPH)

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PPT TOXIC

INTERACTIONS

- INDUSTRY
  - PSG, EXXON, API
- UNIVERSITIES
  - WSU, COL ST, UNIV OF ILL, UNIV OF CINCI
- EPA
  - IAGS, TOXICOLOGY CONFERENCE
- ASC/EM
- JANNAF
- ARMY
- NAVY
- AFOSR
- AF LABORATORIES
  - PL
  - WL
    - MLSE, MLBT, POS, FIV
  - AL
    - OEM: OCC MEDICINE, TOXICOLOGY AND IH CONSULTANTS
    - EQ: ENVIR. ASSESSMENT
- HSC/XRE
  - TPIPT FOR ESOH

TRI-SERVICE TOXICOLOGY

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Briefing: Risk Assessment of Hazardous Materials: The Role of Toxicology

Briefed by: David R. Mattie, Ph.D., DABT
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Summary:

The presentation started with an explanation of the chemical risk assessment process and the need for health-based approaches to identify and characterize potential hazardous substances.

The risk assessment process can be applied to both workplace and environmental settings.

Toxicology was defined and related to the risk assessment process.

Issues were discussed such as requirements for testing and problems with extrapolation of data.

A brief overview of toxicity screens and tests was presented in order to help make toxicity data more meaningful.

Toxicity data for several chemicals of interest were presented as examples.

The presentation concluded with a description of Tri-Service Toxicology; what it is, who points of contact are and what this laboratory can provide to the DOD, industry and academia.

Runway Deicing Technologies And Chemicals

SMSgt Earl LaBonte
HQ AFCESA/CEOM

Overview

- Approved deicers today
- Reduction of harmful deicers
  - Urea/Ethylene Glycols
- Alternative chemical deicers
  - Liquids and Solids
- Runway Ice Detection System
- Future
- Summary

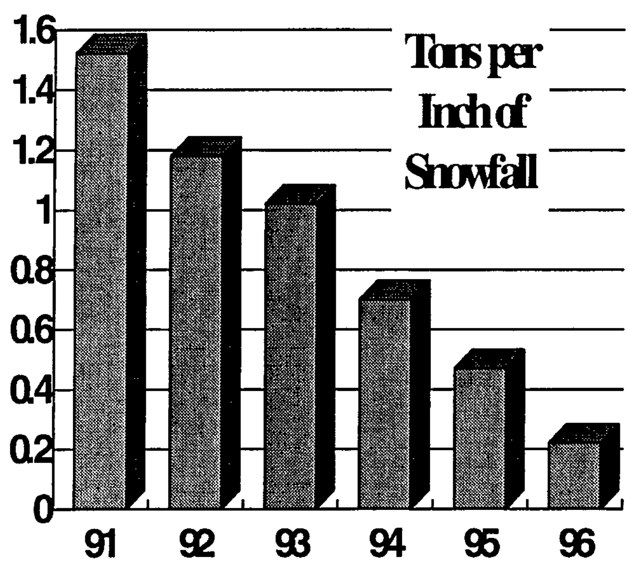
Approved Chemicals

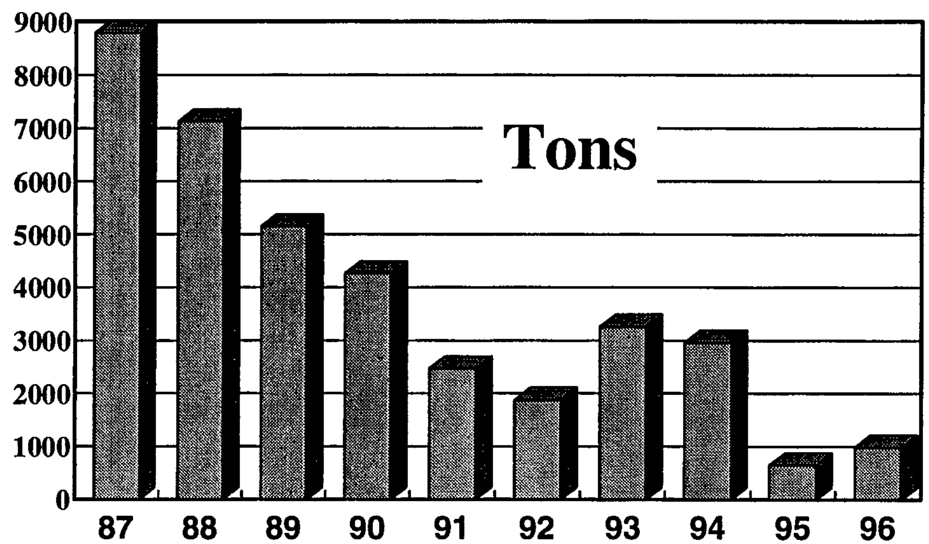
- Isopropyl Alcohol (Federal Specification TT-I-735a)
- Propylene Glycol (SAE AMS 1435)
- Potassium Acetate (SAE AMS 1435)
- Urea (MIL SPEC DOD-U-10866D or SAE AMS 1431A)
- FAA Grade Sand

Reduction in Harmful Deicers

- Urea
  - Abuse as a deicer led to fish kills in Europe
  - Degradation depletes oxygen in waterways
  - Many states restricting urea-laden runoff
- Ethylene Glycol Deicers
  - AF/CE banned purchases in 1992
  - Users were allowed to deplete existing stock

Urea Consumption





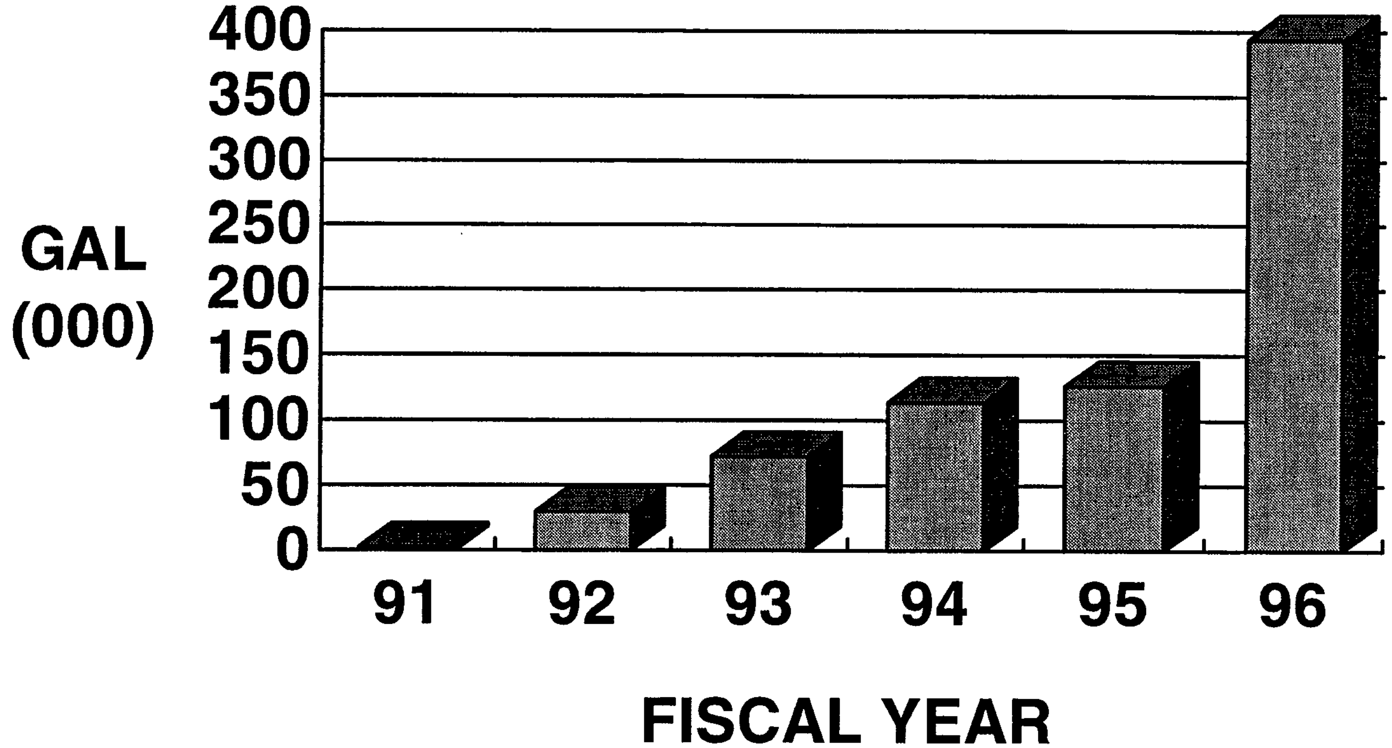
Liquid Deicer Alternative: Potassium Acetate (KAc)

- Benign Deicer (Environmentally Friendly)
- 95-96 Use up 300% Over Previous Year
- Price Continues to Decrease
- NSN 6850-01-341-9855 and 6850-01-341-9856
- Ensure Contracting Uses the Correct Specification (AMS 1435)
- Requires Computer-Controlled Application to Properly Dispense

Potassium Acetate Precautions

- Two primary concerns
  - Airfield lighting faults observed at JFK
  - Corrosion of F-16 ECM Pods at Eielson
- No known adverse effects on pavements
- Slightly corrosive:
  - Store in poly or stainless steel tanks
  - Wash application equipment thoroughly

KAc Usage Trend



Alternative
Solid Deicers Testing

- Alternative Solid Deicers
  - Sodium Acetate
  - Sodium Formate
- Objectives of prospective solid deicer test
  - Will they serve as substitute for urea?
  - Are they more or less effective?
  - Do they require specialized handling?
- Test Shortfall - no side by side comparison with urea

Test Results
Sodium Acetate

- Tested at Elmendorf AFB AK Snow Seasons 94/95 and 95/96
  - OBSERVATIONS
    - Cost is high - $1300/ton
    - Does not require special application equipment
    - Environmental Impact
      - Oxygen demand lower than Urea (Good)
  - Good Potential as a Substitute for Urea

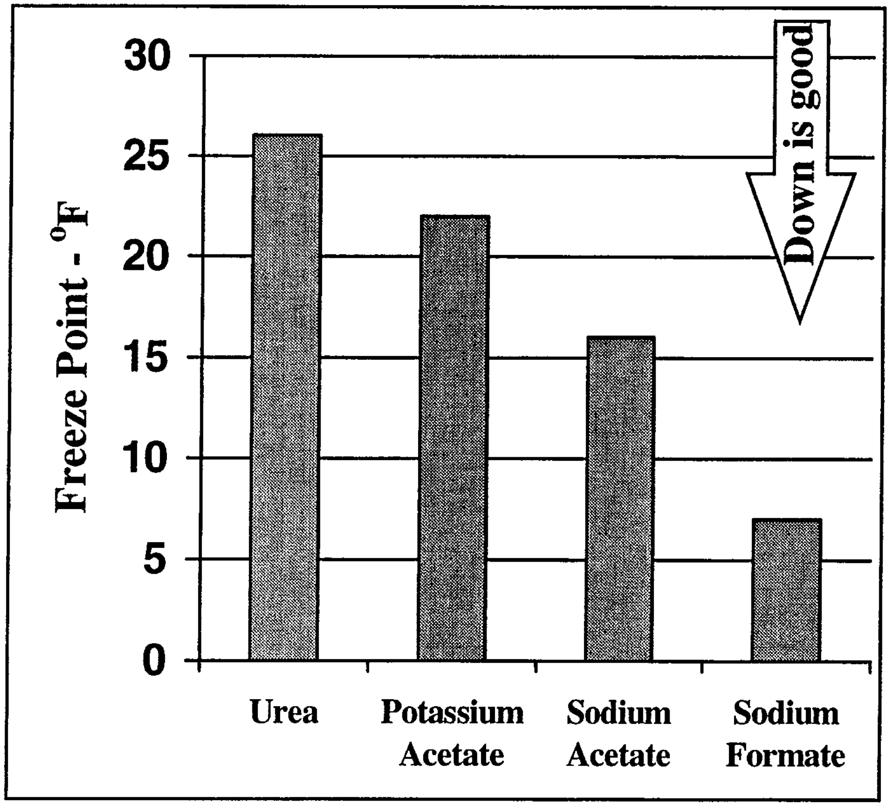
Test Results
Sodium Formate

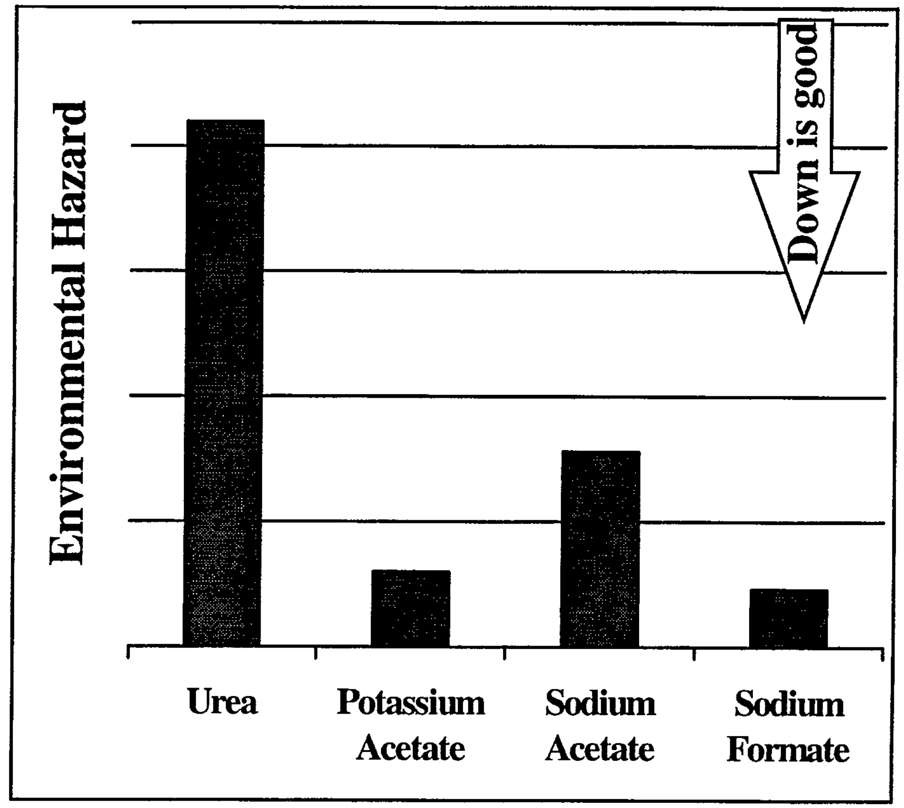
- Tested at Minot AFB ND Snow Season 95/96
  - Observations
    - Cost is high - $900/ton
    - Shape of granules is an advantage
    - Does not require special application equipment
    - Environmental Impact
      - Oxygen demand lower than urea (Better)
  - Good Potential as a Substitute for Urea
- Caking problem observed
  - Manufacturer states problem corrected

Application Rates

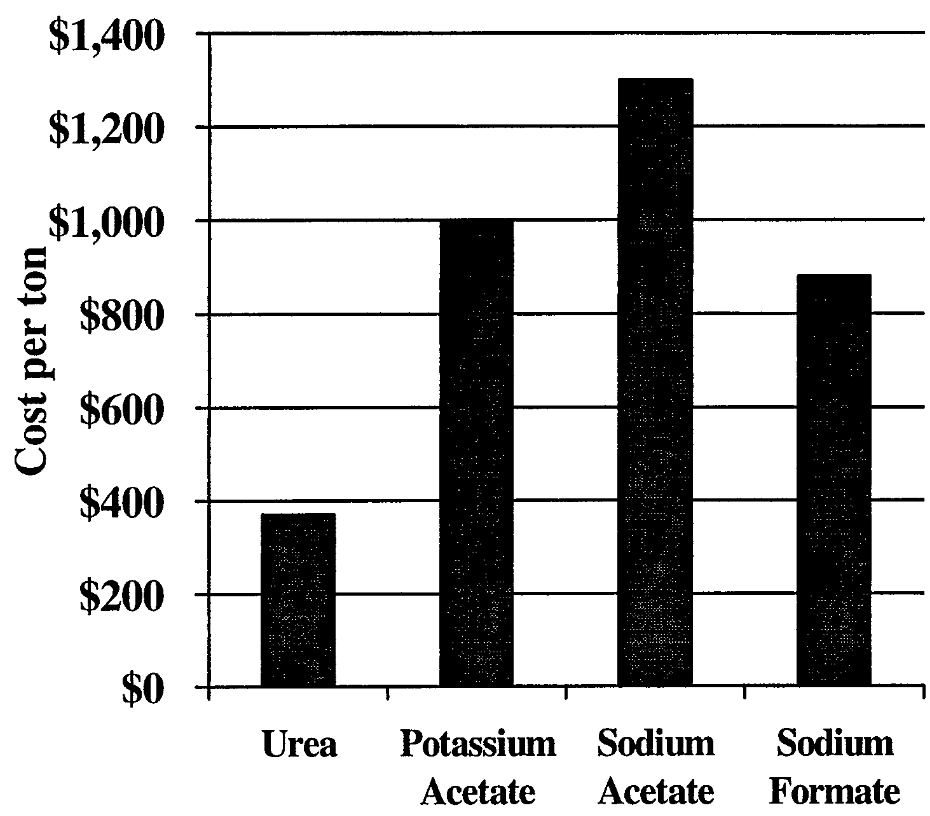
Urea lbs/1000SF @ 20 F	Sodium Acetate lbs/1000SF	Sodium Formate lbs/1000SF	
60.97	23.45	24.67	1/32 inch
82.00	43.60	47.30	1/16 inch
124.06	83.89	92.55	1/8 inch

Freeze Point and Environmental Hazard





Comparisons



- Urea
  - Environmentally harmful
- Potassium Acetate
  - Corrosive
- Sodium Acetate
  - Expensive
- Sodium Formate
  - Material caking problems

Comparison Report

	Urea	Potassium Acetate	Sodium Acetate	Sodium Formate
Effectiveness	Low	Moderate	Moderate	High
Environmental Hazard	High	Low	Moderate	Low
Cost	Low	Moderate	High	Moderate
Ease of Handling	Good	Good	Moderate	Hard, improving
Corrosiveness *all meet AMS*	Low	Moderate	Low	Low

Runway Ice Detection System

- Information provides
  - Presence and Location of ice/water/frost
  - Forecast pavement and air temp
  - Weather forecast from remote source
    - Available Option
- Results:
  - Reduced amount of chemical distribution
  - Reduced frequency of operations
  - Reduces materials and manpower

Snow & Ice Control Challenges

- Right Chemical for Circumstances
  - Climatology
  - Geography
- Right Application for Conditions
  - Freezing Rain, Snow
- Exhaust Mechanical Methods First
- GOAL: Seek alternative deicers rather than costly collection methods

Future

- New chemicals
  - Potassium Formate
- Equipment upgrades
- Mobile sensors for pavement temperatures

Summary

- Must decrease urea usage; Draw down to zero by FY98
- Must field alternatives
- Develop integrated approach to operations
  - Maximize mechanical snow & ice removal
  - Minimize chemical application
  - Enhance detection; Deploy new technologies
  - Re-think A/C ops: plan for launch delays when possible
- Make incremental improvements annually

References

- USAF S&IC bible: AFI 32-1045
- FAA Advisory Circulars (AC) provide helpful additional information
- Commercial Publications

DEICING VEHICLES

Naval Air Warfare Center, Aircraft Division
Paul Swindell, Team Leader
Code 11X714B, Blg. 562/1
DSN624-1926/COML 908-323-1926
Lakehurst, New Jersey 08733

CURRENT STATUS

USN HAS TWO TYPES OF DEICERS:

TRUCK MOUNTED - TM1800/D-40D

TACTICAL - TOWABLE

ALL USE ETHYLENE/PROPYLENE GLYCOL ONLY

ALL SPRAY WATER/GLYCOL MIXTURE

NAVAL AIR WARFARE CENTER
AIRCRAFT DIVISION
LAKEHURST, NJ

CURRENT PLAN

REPLACE D-40D WITH TM1800

USE EXISTING USAF CONTRACT WITH LANDOLL CORP

BOUGHT ONE UNIT IN FY96 TO PROTOTYPE HOT AIR SYSTEM

UNIT DUE IN MAY 97 TO BE TESTED AT NAS BRUNSWICK

PROTOTYPE TO MIRROR EXISTING USAF CONFIGURATION USED FOR PAST 5 YRS

ESTIMATED REDUCTION OF GLYCOL USE OF UP TO 50%

FUTURE POSSIBILITIES

PROTOTYPE SEVERAL TECHNOLOGIES TO REDUCE GLYCOL USAGE:

VACUUM RECOVERY TRUCK

ROLL MAT RECOVERY SYSTEM

BIOLOGICAL TREATMENT IN HOLDING PONDS

AIRCRAFT DE-ICING

- IF YOU CAN'T WINTER BASE AT MACDILL, THEN ....

1 30 Aug 96

ENVIRONMENTAL DRIVERS

- CLEAN WATER ACT DOES NOT PERMIT PROPYLENE GLYCOL TO BE DISCHARGED INTO THE STORM WATER
- WINTER OPERATIONS MUST MINIMIZE THE AMOUNT OF PROPYLENE GLYCOL DISCHARGED TO STORM WATER

2 30 Aug 96

THE INSTALLATION STORM WATER POLLUTION PREVENTION PLAN WILL IDENTIFY THE MATERIALS YOU CAN ALLOW TO ENTER STORM WATER WITHOUT A PERMIT. PROPYLENE GLYCOL IS **NOT** AMONG THEM.

THE CLEAN WATER ACT DOES NOT PERMIT PROPYLENE GLYCOL TO BE DISCHARGED INTO THE STORM WATER. WE HAD TO GET SMART REAL FAST , TO MEET OUR OBJECTIVES AND MINIMIZE THE AMOUNT OF PROPYLENE GLYCOL USED. THE DAYS OF WASHING THE AIRCRAFT WITH HUNDREDS OF GALLONS OF DEICING FLUID ARE GONE, BOTH FOR ENVIRONMENTAL AND ECONOMIC REASONS: COST IS APPROX. $4.50 PER GAL.

AIRCRAFT DE-ICING

- **OPERATIONS MUST MAKE THE BEST WEATHER DECISION:**
  - WEATHER CONDITIONS
  - RCR
  - PERSONNEL AVAILABILITY
  - HANGAR SPACE
  - MISSION REQUIREMENTS
  - DE-ICING CAPABILITY

3 30 Aug 96

OPERATIONS MUST BE WILLING TO PRIORITIZE ITS MISSIONS TO WORK WITHIN THE CAPABILITY OF THE MAINTENANCE UNIT TO GENERATE AIRCRAFT.

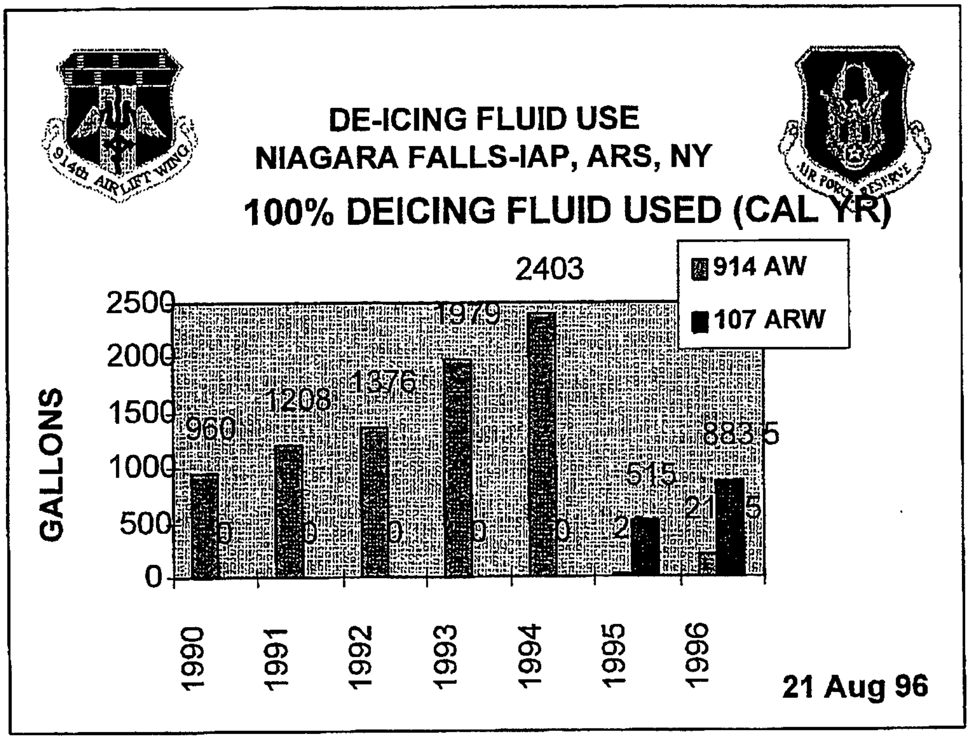
CREATIVE SCHEDULING CAN MINIMIZE THE LOSSES DUE TO WX CANCELLATIONS.

A LOT OF PLANNING AND COOPERATION FROM ALL SECTIONS MUST COME TOGETHER TO MAKE OUR PLAN WORK. OPERATIONS MUST MAKE SOUND WEATHER DECISIONS BEFORE , DURING AND AFTER FLYING. WE CAN GET LAKE EFFECT SNOW THAT CAN CLOSE OUR RUNWAYS DOWN IN A MATTER OF MINUTES. AIR CREW MUST BE FACTORED IN. AS AN EXAMPLE THE BASE MAY NOT HAVE ANY SNOW BUT THE SURROUNDING AREA COULD BE GETTING BURIED, CAN THE AIR CREWS MAKE IT IN? WOULD THEY BE ABLE TO GET HOME ? SOME DRIVE 50 TO 100 MILES .

CAN THE RUNWAYS AND TAXI WAYS GET PLOWED ? WE HAVE A CONTRACTOR , TATE SERVICES , WHO HAS DONE AN EXCELLENT JOB OF PLOWING , BUT WOULD THIS BE PART OF THE CONTRACT OR OVERTIME ? COULD THE PLOW DRIVERS MAKE IT IN ?

CAN THE FLYING BE RESCHEDULED? DO WE REALLY NEED TO FLY OR CAN WE ADD THE TRAINING REQUIREMENT ON TO A CROSS COUNTRY ?

IF IT WAS SNOWING , AND WE DID DE-ICE , WOULD IT FALL WITHIN THE HOLD OVER TIME BEFORE THE AIRCRAFT TOOK OFF? WE HAVE NO LAST CHANCE DEICING

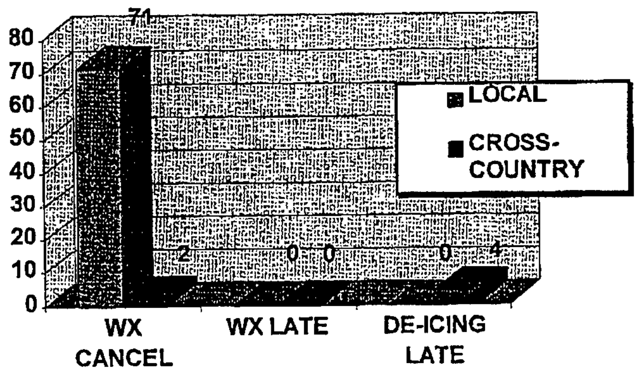

DE-ICING FLUID USE
NIAGARA FALLS-IAP, ARS, NY
100% DEICING FLUID USED (CAL YR)
914th AIRLIFT WING
AIR FORCE RESERVE
914 AW
107 ARW
GALLONS
2500
2000
1500
1000
500
0
960
1208
1376
1979
2403
515
883
1990
1991
1992
1993
1994
1995
1996
21 Aug 96

288

9l4th AIRLIFT WING

914 AW WX DEVIATIONS
NOV 95 THRU APR 96

AIR FORCE RESERVE



21 Aug 96

AIRCRAFT DE-ICING

- IF YOU DECIDE TO FLY:
  - ALTER SCHEDULE TO WORK WITH THE WEATHER:
  - HANGAR AIRCRAFT
  - DELAY DEPARTURES TO PERMIT SOLAR OR MANUAL DE-ICING

6 30 Aug 96

IF WE DO DECIDE TO FLY , AND WE MAKE EVERY EFFORT TO MEET THE FLYING SCHEDULE , OUR FIRST CHOICE WOULD BE TO HANGAR THE AIRCRAFT. OUR RADIANT HEAT IN THE MAIN HANGAR CAN MELT TWO INCHES OF SNOW AND ICE IN TWO HOURS. WE ALTERED OUR ISO SCHEDULES TO KEEP THE MAIN HANGAR OPEN DURING OUR DEICING MONTHS. WE ALSO TOW OUR NEXT DAY FLYERS IN THE HANGARS BEFORE GOING HOME .

IF THE HANGARS CAN'T BE MADE AVAILABLE , BRUSHING OFF THE SNOW AND LETTING THE SUN WARM THE METAL DOES A BETTER JOB THAN PUTTING A COUPLE HUNDRED GALLONS OF FLUID ON THE AIRCRAFT. THIS MAY DELAY DEPARTURE BUT THE AIRCREWS NEED TO UNDERSTAND.

AIRCRAFT DE-ICING

- IF YOU HAVE TO FLY
  - USE YOUR DESIGNATED DE-ICING SPOTS
- NO SPOTS? DE-ICE IN PLACE
  - WORK WITH THE WEATHER
  - BLOCK THE STORM DRAINS
  - USE THE CORRECT MIXTURE
  - CONTINUOUSLY VACUUM

7 30 Aug 96

IF WE HAVE TO FLY AND FOR SOME REASON THE AIRCRAFT WASN'T HANGARED, THEN WE USE THE DESIGNATED DEICING PADS OR SPOT DE-ICE. IF WE CAN'T GET ON THE DE-ICE PADS THEN WE SPOT DE-ICE. WE HAVE WRITTEN PROCEDURES. BASICALLY, WE CLEAR THE DESIGNATED SPOT OF SNOW, USE THE HOT AIR BLASTER TO CLEAR THE AIRCRAFT OF SNOW, AND DE-ICE USING THE PROPER MIXTURE IAW TO 42C-1-2.

FOR OFF-PAD DE-ICING, USE OUR TENANT VACUUM SWEEPER AND OUR MODIFIED TYMCO SWEEPERS TO CLEAN UP THE RUNOFF. WE ALSO INSTALL DRAIN BLOCKERS AND PIGS AROUND THE CLOSEST DRAIN WHERE FLUID MIGHT MIGRATE.

DE-ICING ON A PAD

- PLOW THE RAMP AS CLEAN AS YOU CAN BEFORE YOU BEGIN TO DE-ICE
- REMOVE AS MUCH SNOW AS YOU CAN BEFORE YOU MOVE AIRCRAFT ONTO PADS
- USE HOT AIR BLASTER, BROOMS, ETC.

8

30 Aug 96

WE HAVE 3 DESIGNATED DE-ICING PADS THAT ARE DESIGNED TO HANDLE DE-ICING FLUID RUN OFF. THROUGH THE USE OF A HOLDING PIT AND FLAPPER VALVES, THEY CAN BE CONNECTED TO EITHER THE SANITARY SEWER SYSTEM OR THE STORM WATER DRAINS. WHEN IN THE DE-ICE MODE, THE NIAGARA FALLS SANITARY SEWER DISTRICT, BY PERMIT, WILL ACCEPT 2500 GALLONS OF PRODUCT EACH DAY. THE SAME PROCEDURES AS SPOT DE-ICING APPLY. THE PADS MUST BE PLOWED OF SNOW, AND THE AIRCRAFT MUST BE HOT AIR BLASTED OR SWEPT AS CLEAN AS POSSIBLE TO CUT DOWN ON THE AMOUNT OF FLUID THAT IS SPRAYED, WHICH REDUCES THE AMOUNT OF RUN OFF TO BE COLLECTED AND RUN THROUGH THE SYSTEM.

DEALING WITH ENVIRONMENTAL ISSUES

- WORK WITH YOUR STATE REGULATORS
- ESTABLISH REPORTING CRITERIA
- GET YOUR REGULATOR INVOLVED EARLY
- IF DE-ICING FLUID GETS AWAY FROM YOU, TREAT IT AS A SPILL

9 30 Aug 96

THE STATE REGULATORS MUST BE KEPT IN THE LOOP. THEY WERE PART OF OUR PROCESS IN EVERY WAY FOR GUIDANCE AND INTERPRETATION OF THE REGULATIONS.

DEALING WITH ENVIRONMENTAL ISSUES

- **MAKE CLEAR THE OPTION OF LAUNCHING ALL AIRCRAFT INTO THE TEETH OF THE STORM IF A NATIONAL CONTINGENCY EXISTS-- EVEN IF YOU HAVE TO SQUIRT GLYCOL EVERYWHERE**
- **YOUR REGULATOR WILL UNDERSTAND (ALTHOUGH YOUR BOSS MAY STILL GO TO JAIL)**

10 30 Aug 96

NIAGARA FALLS DID MAKE IT CLEAR TO THE STATE REGULATORS THAT IN A NATIONAL EMERGENCY WE WOULD HAVE TO LAUNCH 18 AIRCRAFT (8 C130'S AND 10 KC-135'S) . THE MOST CONSERVATIVE DE-ICING PROCEDURES WOULD BE USED TO SAFELY LAUNCH ALL THE AIRCRAFT WITH A MINIMUM IMPACT TO THE ENVIRONMENT

DE-ICING LESSONS LEARNED

- TENANT VACUUM TRUCK WORKS WELL
- MODIFY YOUR TYMCO RAMP VEHICLES FOR LARGE DEICING
- *PIGS/DRAIN BLOCKS* WILL STOP FLUID FROM GETTING INTO THE STORM DRAINS

11 30 Aug 96

NIAGARA FALLS MODIFIED ITS TYMCO RAMP SWEEPERS TO VACUUM UP DEICING FLUIDS AT A COST OF $5,000.00 EA. THESE SWEEPERS WORK AROUND THE AIRCRAFT DURING AND AFTER DE-ICING . WE ALSO USE A SMALL TENANT VACUUM TRUCK THAT CAN GO UNDER THE AIRCRAFT WHILE WE DE-ICE. SPILLBLOCKER DIKES , DRAINBLOCKERS AND PIGS ARE ALL PART OF THE PROCESS TO KEEP THE DE-ICING FLUID FROM GETTING TO THE STORM WATER DRAINS OR OFF THE RAMP.

DE-ICING LESSONS LEARNED

- PREVENTION THE BEST MEDICINE
  - FORECAST DE-ICING REQUIREMENTS FOR THE NEXT DAY
  - ALTER FLYING SCHEDULE IF YOU CAN
- ENSURE CHECKLISTS AND EMERGENCY PROCEDURES ARE IN PLACE IF SOMETHING GOES WRONG

12

30 Aug 96

AIRCRAFT DE-ICING

- CONTRACT TO HANDLE YOUR WOES
- NEW TECHNOLOGY
  - ENVIRONMENTALLY FRIENDLY DEICING FLUID
  - RECYCLING: PROPYLENE INTO WATER
  - INFRARED

13 30 Aug 96

-- CONTRACTORS ARE AVAILABLE: ZENON CHARGES PEARSON AIRPORT IN TORONTO $12 MILLION PER YEAR.

-- WRIGHT LABS AND NASA ARE WORKING ENVIRONMENTALLY FRIENDLY DEICING FLUIDS:

-- AFLMA FINAL REPORT LM 9416500: EXPLORING AVAILABLE DEICING TECHNOLOGIES (MSG STANLEY MYNCZYWOR)

THE KEYS TO AIRCRAFT DE-ICING

- **MINIMIZE GLYCOL USE:**
  - WEATHER CANCEL
  - THERMAL/MECHANICAL DE-ICE
- **BLOCK THE DRAINS; VACUUM**
- **WORK WITH THE REGULATORS**

14 30 Aug 96

THE KEYS TO A GOOD PLAN:

MINIMIZE DE-ICING
PLANNING
WEATHER CANCEL
THERMAL AND MECHANICAL DE-ICING
STOP UP DRAINS
VACUUM
WORK WITH REGULATORS

15 NOV 1994

MEMORANDUM FOR CEO
DO
LG
PA
SG
JA

FROM: CE

SUBJECT: De-icing/Anti-icing of Planes, Aprons, and Runways

1. The ultimate goal of the storm water regulations (40 CFR 122-124) is zero discharge of industrial pollutants into the waters of the United States. A rigorous interpretation of these regulations indicates that any airport discharging storm water mixed with de-icing/anti-icing compounds from the boundary of the property could receive a Notice of Violation (NOV) from the state or federal Environmental Protection Agency (EPA).

2. Zero discharge of de-icing/anti-icing compounds is the long term goal. In the interim, the amount of these compounds in storm water runoff must be minimized by the institution of Best Management Practices (BMPs). These practices minimize the discharge of pollutants into the receiving waters and can include managerial changes, equipment modifications, and large scale construction projects. A point paper describing many of these BMPs is attached for your information.

3. HQ AFRES will have to choose BMPs that will minimize the impact of de-icing/anti-icing compounds on water quality while still meeting operational and mobilization requirements. This will require cooperation among various sections of AFRES. A de-icing working group is being established to develop the command policy on de-icing/anti-icing. Request that you appoint a representative to this working group The first meeting is scheduled for 30 Nov 94, at 1330 in the CE conference room.

4. The point of contact for this issue is Ms. Susan Stell, CEVC, extension 71078.

BG Clary

BOBBY G. CLARY
The Assistant Civil Engineer

Attachment:
Point Paper

POINT PAPER ON THE MANAGEMENT OF DE-ICING/ANTI-ICING COMPOUND RUNOFF INTO THE WATERS OF THE UNITED STATES

The ultimate goal of the storm water regulations (40 CFR 122-124) is zero discharge of industrial pollutants into the waters of the United States. A rigorous interpretation of these regulations indicates that any airport discharging storm water mixed with de-icing compounds from the boundary of the property could receive a Notice Of Violation (NOV) from the state or federal EPA. This has occurred very infrequently to date because all air traffic during the winter in the northern climes would be effectively prohibited. It must be noted, though, that the Greater Pittsburgh ARS is currently under an administrative order that prohibits the discharge of propylene glycol from aircraft de-icing to the waters of the U.S.

Storm water runoff from industrial activities is not prohibited by federal storm water regulations; however, the amount of contaminants in the runoff must be minimized by the institution of Best Management Practices (BMPs). These practices minimize the discharge of pollutants into the receiving waters and can include managerial changes, equipment modifications, and large-scale construction projects.

It is likely that federal and state regulations concerning storm water associated with industrial activity will become more stringent in the future. The discharge of storm water contaminated with de-icing/anti-icing compounds will become increasingly regulated and enforcement actions will become more frequent. The bottom line is that de-icing/anti-icing compounds will have to be collected and treated or recycled in the future at all airports. AFRES should be working towards a short-term goal of minimizing the presence of these compounds in storm water runoff and a long-term goal of zero discharge of these compounds from the aprons and runways into the waters of the U.S.

In the interim, AFRES will have to institute both general and base specific BMPs to minimize the impact of de-icing/ anti-icing compounds on stream quality. The BMPs must be consistent with Air Force.(AFI) and Federal Aviation Administration (FAA) regulations. They will require cooperation among various sections of AFRES such as CE, DO, LG, PA, and SG. A meeting among these sections is recommended so that a consensus can be reached on mutually acceptable BMPs. Since de-icing/anti-icing is an Air Force wide issue, it is also recommended that a request be made for the establishment of a working group at the USAF/CEV level.

The following is a list of BMPs that might be instituted to minimize the effect of de-icing/anti-icing compounds on receiving water quality. They are in no particular order and any brand names mentioned are for illustrative purposes only, rather than an endorsement of the manufacturer's product.

1. Unless the mission is critical, do not fly during inclement weather.

2. If a plane must be flown, place it in the hanger the day before.

3. Modify street sweeping equipment to vacuum up the de-icing fluid. (Cost is about $7000/street sweeper).

4. Purchase a dedicated vacuum system for de-icing chemical recovery. (Tennant 1550 Power Scrubber, cost ~$80,000 or Mobile Recovery Plant De-Icing System or Tymco Model 600 Sweeper, cost ~$105,000, for example).

5. Anti-ice rather than de-ice. If the weather forecast indicates inclement weather, anti-ice aprons and runways regardless of the time of day, rather than de-ice after the precipitation.

6. Keep aprons and runways mechanically scrapped clean so that a minimum of de-icing/anti-icing is necessary.

7. Plug storm sewers with a collapsible, reusable balloon and suck out the fluid. "Stream Saver" by ILC Dover, Inc. is one such apparatus used at Dover AFB and the airport at Philadelphia. (Cost is about $8000).

8. Construct a de-icing pad with a collection system or modify an existing area. This BMP may be necessary at all bases affected by inclement weather. (Cost ~$300K to 2000K).

9. Install a gantry system that has recapture capabilities. (Cost is about $3-7 million). The KX Kallax De-Icing System is one such system.

10. Properly calibrate de-icing dispensers.

11. Apply de-icers only where needed.

12. Use a washrack attached to the sanitary sewer for de-icing. (This BMP requires prior approval from the POTW).

13. Remove snow on airplanes with brooms or other mechanical means prior to de-icing.

14. Install a Runway Ice Detection System (RIDS). (Cost ~$200K).

15. Use a distillation unit to recover glycols. The minimum concentration of glycol in the collected solution must be ~10%.

16. Have a contractor pick up and dispose of the stored solution of glycol and water.

17. Install a portable mat with a fluid recapture system. (Pure Mat, for example).

18. Build detention ponds for the capture of the de-icing compounds and meltwater.

19. Use a package biological treatment unit to treat the de-icing wastewater.

20. Irrigate with treated wastewater.

This list is not all inclusive. More than one BMP may be needed and some combination of several of the above BMPs may be the best solution. The process of discussion, choice, and implementation of BMPs to minimize the discharge of de-icing/anti-icing compounds into the waters of the U.S. must begin soon. AFRES needs to show progress so that the risk of another administrative or Notice of violation (NOV) is reduced.

22 Nov 95

MEMORANDUM FOR 934 OG/CD
934 LG/CC
934 SPTG/CD
934 SPTG/CE
934 SPTG/CEV

FROM: 934 AW/CC

SUBJECT: Minimization of Use of Deicing Fluid

1. On 21 Nov 95, we met to discuss the management practices that will be employed by the 934 AW to minimize the use of deicing fluid during the upcoming winter. This memorandum is intended to provide a record of the items discussed and strategies we agreed on at that meeting.

2. Two letters from HQ AFRES/CV, which included anti-icing/deicing guidance, were provided to meeting participants prior to our discussion. These letters affirm that AFRES recognizes the scrutiny being applied to deicing operations by the environmental regulatory agencies. The letters also convey AFRES' support of efforts at bases to reduce deicing fluid use.

3. We agreed that maintaining operational readiness will at times require us to fly in poor weather conditions. However, we also recognize our potential for impact on the environment. Therefore, the following management techniques were discussed and agreed to as ways to minimize our deicing fluid use:

a. Aircraft schedule to fly when poor weather conditions are anticipated will be hangared if possible. An infrared heating system was installed on the hangar last year. Hangaring aircraft has proven to be an effective technique at other facilities. This option will require us to maximize our planning and coordination to ensure that the aircraft scheduled to fly can be hangared when needed.

b. When we know that deicing fluid use cannot be avoided during impending storm conditions, we must coordinate our efforts. Flying schedules need to be communicated to the 934 SPTG/CE. To accomplish this, CE will now be included on the distribution for the flying schedule. We must ensure that the CE is notified when weekend flying is planned, so that personnel are available to respond to deicing with the sweeper trucks. During normal operating hours, CE can be requested to respond to deicing via the

customer service clerk at extension 5360. During off-duty periods, security should be notified to call in the designated personnel.

c. We must remove snow from aircraft and ramp areas as needed before we begin to use deicing fluid. This will enable us to more effectively accomplish collection of used deicing fluid with our sweeper trucks, and thus reduce the amount of fluid in runoff to storm sewers. This will also help us to alleviate MAC concerns about discharge of excessive volumes into their facilities.

d. During periods when poor weather conditions are expected, we will discourage transients from flying non-critical missions to this facility. This will enable us to avoid unnecessary deicing of other aircraft.

4. Our long term strategy includes construction of a deicing pad, to begin in the Spring of 1996. Upon completion of this project, we will be able to capture deicing fluid when its use cannot be avoided, and will more effectively prevent runoff and discharge of deicing fluid. We will seek to incorporate recycling and reuse of fluid if it is possible and does not compromise the safety of our flyers.

5. We will continue to examine opportunities for implementing pollution prevention measures into our deicing operations. The 934 SPTG/CEV will further investigate higher efficiency spray nozzles adopted and used by Northwest Airlines for frost conditions on their aircraft. We will seek to make use of this innovation to reduce the volume of fluid dispensed in frost or light ice conditions.

6. All of our management strategies will be best achieved if we strive for effective communication and coordination between organizations that play a role in deicing operations. Through this concerted effort, we can maintain our readiness while fulfilling our obligations to protect the environment.

MICHAEL F. GJEDE, Col, USAFR
Commander

cc: HQ AFRES/CEV
934 SPTG/SP

DEPARTMENT OF THE AIR FORCE

AIR FORCE RESERVE

21 FEB 1995

MEMORANDUM FOR SEE DISTRIBUTION

FROM: AFRES/CV
155 2nd St
Robins AFB GA 31098-1635

SUBJECT: Anti-icing/De-icing of Planes, Aprons, and Runways

1. Storm water mixed with runoff from de-icing operations is receiving increased scrutiny from the United States Environmental Protection Agency (USEPA) and state regulators. The ultimate goal of the storm water regulations is zero discharge of pollutants into the waters of the United States. A rigorous interpretation of these regulations indicates that any airport discharging storm water mixed with anti-icing/de-icing compounds from the boundary of the property into the waters of the United States could receive a Notice Of Violation (NOV) from the state or the USEPA. As emphasized in the past, AFRES facilities can be held liable for fines or penalties assessed by regulators.

2. Zero discharge of anti-icing/de-icing compounds is our long-term goal. Bases should plan, program, and execute projects necessary to accomplish this goal. In the interim, the amount of these compounds in storm water runoff must be minimized by the institution of Best Management Practices (BMPs) which reduce the discharge of pollutants into receiving waters. Anti-icing BMPs are defined as practices used prior to or at the start of a storm event, whereas de-icing BMPs are practices used during or after a storm event. Both types of practices can be used on planes, aprons and runways.

3. Anti-icing/de-icing guidance for AFRES bases during the 1995 winter season is shown in the attachment.

4. All applicable AFIs and T.O.s are to be followed. This guidance is not to be interpreted as superseding any of these instructions. Pilot, crew, and community safety is our first priority. However, the unit commander can and will be held liable, through installation O & M funds, for any fines or penalties assessed by regulators. These can be severe. Unit commanders must weigh all factors before commencing de-icing operations which may discharge pollutants into the waters of the United States.

5. Points of contact for this guidance are Mr. J.E. Dennard, HQ AFRES/CEO, DSN 497-1036; Ms. Susan Stell, HQ AFRES/CEV, DSN 497-1078; Lt Col Whitlow, HQ AFRES/DO, DSN 497-1139; and Mr. Paul White, HQ AFRES/LG, DSN 497-1645. Questions are to be directed to these individuals, depending on the area of concern.

James E. Sherrard

JAMES E. SHERRARD III, Maj Gen, USAF
Vice Commander

Attachment:
Anti-icing/De-icing Guidance

ANTI-ICING/DE-ICING GUIDANCE

A. Commanders should use anti-icing procedures to the maximum extent possible. In those circumstances when de-icing is necessary, commanders should evaluate the necessity of generating and executing each sortie. He/she should consider the impact of a mission cancellation or delay on such things as combat readiness, aircrew currency, customer requirements, environmental contamination, and safety. Whenever practicable, the commander should consider delaying a mission to avoid excessive de-icing and reducing the potential for damage to the environment.

B. If the unit commander or OG/CC determines that the mission must be flown, the emphasis is to be on anti-icing best management practices rather than on de-icing practices. Close monitoring of developing weather systems would permit the delay of routine training or the prepositioning of aircraft clear of the freezing precipitation or the hangaring of scheduled aircraft.

C. Suggested anti-icing/de-icing BMPs for aircraft include the following which are rated in order of preference.

(1) Place the aircraft in a hanger if a storm event is expected.

(2) Educate personnel on proper equipment and operating procedures (T.O. 42C-1-2).

(3) Calibrate equipment and chemical usage.

(4) Use a de-icing pad, if available.

(5) Use an aircraft washrack connected to a sanitary sewer, if available and if the Publicly Owned Treatment Works (POTW) agrees to accept the de-icing compounds.

(6) Avoid excessive overspray on aircraft.

D. Anti-icing and de-icing practices for aprons and runways include the following which are rated in order of preference.

(1) Educate personnel on proper equipment and operating procedures (T.O. 42C-1-2 and AFI 32-1045).

(2) Start anti-icing when the storm event is imminent or just beginning. Pay overtime if necessary.

(3) Anti-ice/de-ice aprons and runways only where needed.

(4) Attempt to mechanically scrape the areas clean prior to resorting to chemical use.

(5) Calibrate equipment and chemical usage.

(6) Potassium acetate is preferred over urea or the glycols.

911 Airlift Wing
Pittsburgh International Airport
Air Reserve Station

Aircraft De-icing Fluid Collection System

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Background**
  - Administrative Order issued by PA DEP (formerly DER) on 12 Mar 93
    - Required to cease unauthorized discharge of de-icing fluids
    - Addition to earlier Administrative Order of 19 Jan 93 issued to major carriers at PIA
    - Resulted from PIA de-icing operations in Dec 92 which caused fish kills in local waters

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Background**
  - 911 AW suspended all de-icing operations on 10 Feb 93
    - Aircraft kept in hangers
    - Flights suspended due to bad weather
  - Administrative Order stipulated requirements:
    - Plan for permanent abatement of discharges to be submitted by 1 May 93
    - Plan implementation to be accomplished by 1 Oct 93

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Background**
  - 911 AW Compliance Plan developed Apr 93
    - Project programmed for collection of de-icing fluid discharges
    - De-icing Operations suspended until completion of project
  - Additional requirements issued by PA DEP on 7 Sep 94
    - Monthly de-icing fluid usage records to be submitted
    - Plan for de-icing pad operation procedures required

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Project Scope**
  - 3 collection trenches (12"x12"), valve pit w/diverter valve, 3 catch basins, and drain lines
  - 10,000 gal spent de-icing fluid tank w/dike and overflow controls
  - 4,000 gal de-icing fluid tank w/dispensing system and lean to enclosure
  - Power supply for both tanks

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Project Milestones**
  - Design Start
    - 1 Mar 93
  - Design Complete
    - 1 Jun 93 (90 days)
  - Construction Start
    - 16 Dec 93
  - Construction Complete
    - 20 Dec 94 (1 year)

911 Airlift Wing PIA ARS
Aircraft De-icing Fluid Collection System

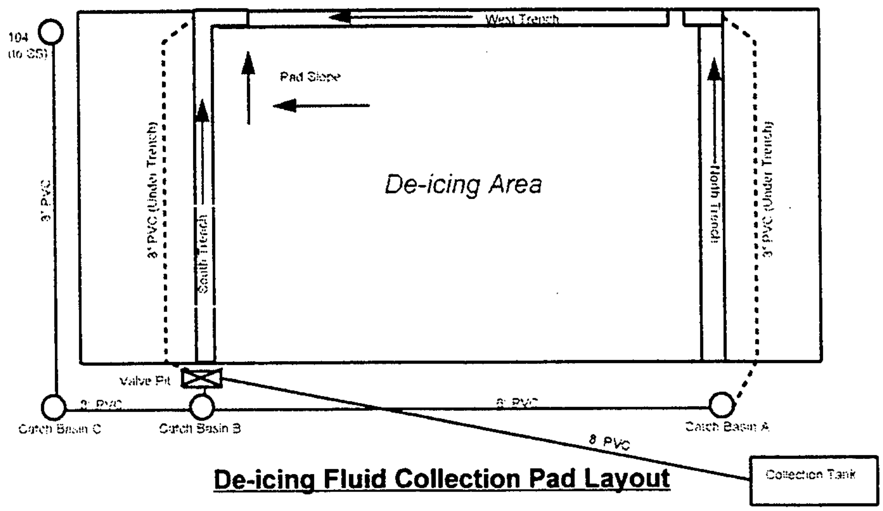
- **Project Cost**
  - Apron Modifications
    - $214,300 (incl. $21,700 for SS mod.)
  - Spent De-icing Fluid Collection System
    - $37,900
  - New De-icing Fluid Dispensing System
    - $44,400
  - **Total Cost**
    - **$296, 600**

911 Airlift Wing PIA ARS
Aircraft De-icing Fluid Collection System

Base Map

911 Airlift Wing PIA ARS

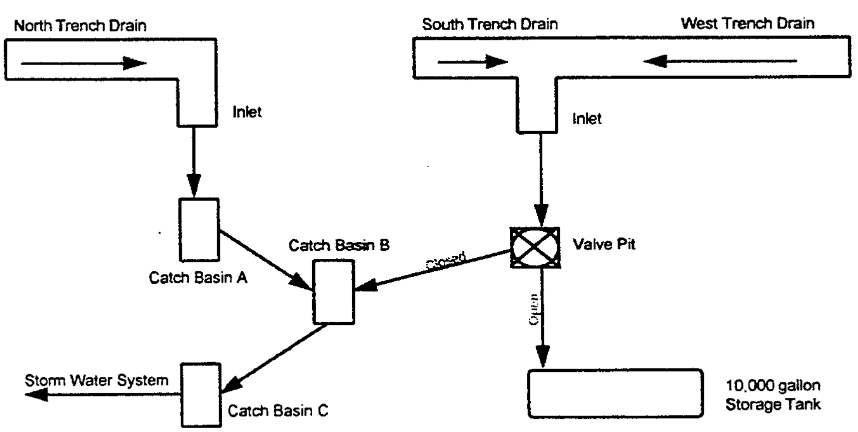
Aircraft De-icing Fluid Collection System



De-icing Fluid Collection Pad Layout

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System



Flow Schematic - De-icing Collection System

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Operational Procedures**
  - Heavy snow removed prior to towing aircraft to de-icing pad
  - De-icing pad valve opened (divert flow to collection system) just prior to spraying aircraft
  - Aircraft de-icing IAW USAF and de-icing system operations manual procedures
  - De-icing pad valve closed NLT 15 min after spraying aircraft

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Operational Procedures**
  - Visual checks of trench drains made before commencing de-icing operation to ensure proper function of collection system
  - De-icing system purged before and after each use to prevent damage from freezing
  - De-icing Log maintained documenting all de-icing operations
    - Monthly reports forwarded to PA DEP

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Usage**
  - Propylene Glycol Type I
    - CY 94-95 De-icing Season
      - 4,300 gal of new de-icing fluid used
      - 10,200 gal of spent de-icing fluid collected
    - CY 95-96 De-icing Season
      - 7,400 gal of new de-icing fluid used
      - 14,700 gal of spent de-icing fluid collected

911 Airlift Wing PIA ARS

Aircraft De-icing Fluid Collection System

- **Conclusion**
  - De-icing system successfully operated for past 2 seasons
    - All unauthorized discharge of de-icing fluid to local waters eliminated
    - Spent de-icing fluid waste reduced through recycling
  - PA DEP issued congratulatory letter on 31 Mar 95 for 911 AW efforts in preventing pollution

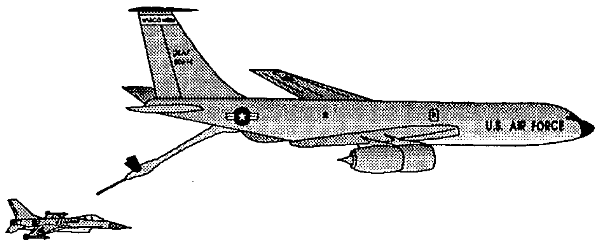
Aircraft De-icing Fluid Collection System
911 Airlift Wing, Pittsburgh International Airport Air Reserve Station

Briefing Summary

The aircraft de-icing fluid collection system at the 911 Airlift Wing (AW), Pittsburgh International Airport (PIA) Air Reserve Station (ARS) was installed in Dec 94 as a result of an Administrative Order (AO) issued by the Pennsylvania Department of Environmental Protection (PA DEP) in Mar 93. The AO cited the 911 AW as a tenant of PIA and required all tenants at PIA to cease any de-icing operations that produced unauthorized discharges into local waters. PA DEP issued the order after fish kills and public complaints regarding odor and discoloration in waters adjacent to PIA occurred during Dec 92. The AO required that compliance plans be developed by all cited parties and submitted to PA DEP for approval.

The 911 AW developed a Compliance Plan in accordance with the AO in Apr 93 that included the design and construction of a de-icing fluid containment and collection system project. Design of the project was completed in-house in Jun 93. Construction of the project was done through a local contract that began in Dec 93 and completed one year later. During project design and construction, the 911 AW halted all de-icing operations and used alternate means to keep aircraft free of ice. The completed project consisted of a 4,000 gallon dispensing tank system for new de-icing fluid, a de-icing pad with surrounding trench drains and collection inlets for runoff collection, and a 10,000 gallon collection tank system for spent de-icing fluid. The total project cost was $296,600 which included associated piping and power requirements.

The main component of the collection system is a diverter valve which allows runoff from the pad either to flow into the base storm sewer system under normal conditions or to be diverted into the collection tank during de-icing operations. As a result, de-icing fluid runoff is contained and collected by the system. All de-icing operations are performed utilizing the collection system and are done according to Air Force requirements and the 911 AW operating manual for the de-icing collection system. The new collection system has been successfully used for the past two de-icing seasons. To date, approximately 25,000 gallons of spent propylene glycol solution has been collected and sent out to be recycled under separate contract. The de-icing fluid collection system has successfully eliminated unauthorized discharge of de-icing fluid to the local waters and has met the requirements of the original AO issued by PA DEP.



Stormwater Detention Ponds

Wisconsin Air National Guard
128th Air Refueling Wing
1Lt Robert Huelsman

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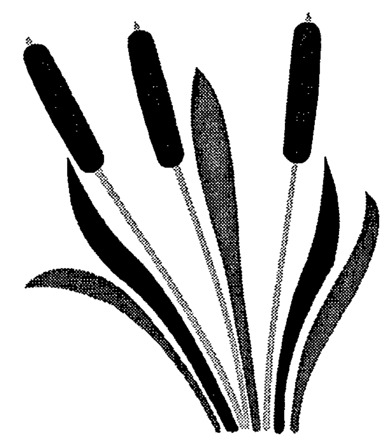
Reducing Glycol Discharge

- Glycol reduction may result from "Low Tech" solutions.
- Holding Ponds could do the work with minimal cost.
- Ponds are natural systems, requiring little maintenance.

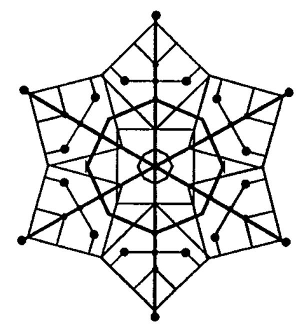


Goal and Objective

- Desired goal is to reduce glycol runoff to the waters of the State.
- By capturing the glycol discharge in a holding pond, the runoff can be degraded naturally.

Today's Situation

- Aircraft are covered with gylcol solutions prior to remove snow and ice.
- Glycol runoff creates large BOD problem for receiving waters.
- No suitable method currently exists to capture and/or treat the runoff.

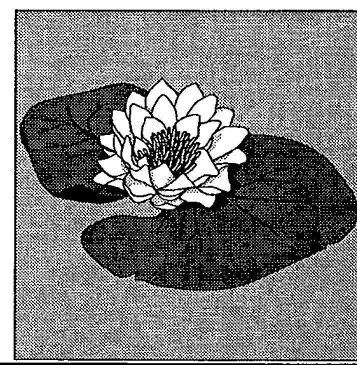


How Did We Get Here?

- Flight safety requires deicing.
- "Do Nothing" alternative may violate stormwater discharge requirements.
- We need a cost effective method to continue flight operations.
- Typical "solutions" involve high costs in equipment and personnel to operate.

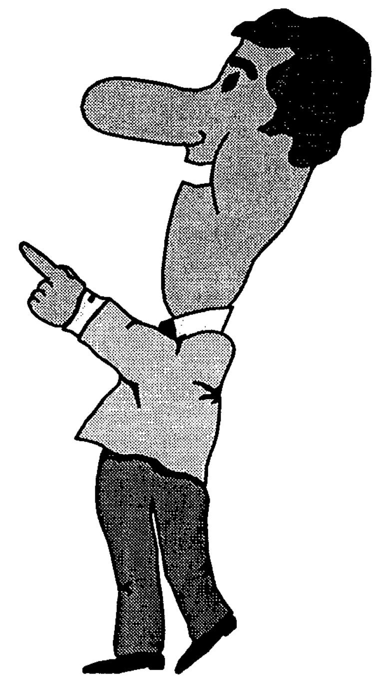
Pond Option

- Holding ponds can store runoff during the winter season.
- Natural processes can treat the holding water during the spring and summer.
- Cost is minimal and personnel requirements are low.



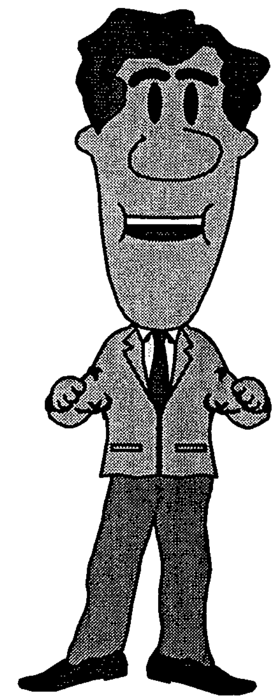
Positive Aspects

- Low to medium cost.
- Minimal personnel needed
- Natural degradation.
- Visually pleasing.
- Can capture other products.
- Decreased liablity.



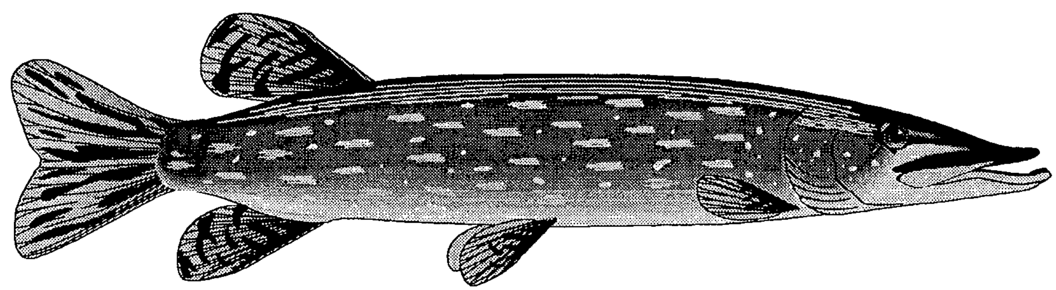
Negative Aspects

- Significant land usage.
- Potential bird attraction.
- Treatment requires time.
- Degradation may not complete.
- Potential wastewater facility.
- Require single outfall.



Recommendation

- Stormwater holding ponds are a cost effective method to hold and treat glycol contaminated runoff.
- The 128th ARW will pursue this method for stormwater protection.



Deicing Equipment and Technologies

DAVE PHILLIPS

Deicing / Anti-Icing Technology

- Deicing Fluid Systems
- Anti-Icing Fluid Systems

Deicing Fluid Systems

- Heater Supplies Fluid at 180 Degrees F
- Premix Fluid System
  - Mixture Derived Manually
- Proportional Mix System
  - Manually Adjustable Valving Yields Desired Mixture of Water and Glycol
  - Provides Hot Water Deicing Capability

Anti-Icing Fluid Systems

- No Recirculating Systems Back to Tank
- Unheated
- Neat Tank - 100%
- Diaphragm Pump Minimizes Mechanical Shearing of Fluid
  - Low Pressure, Low Flow Application Also Minimizes Shearing

New Equipment Developments

- *"Type II" Anti-Icing Fluid System Kits*
- *Enclosed Operator's Cabin Kits*
- *FMC Modular Deicers and Options*

"Type II" Anti-Icing Fluid System Kits

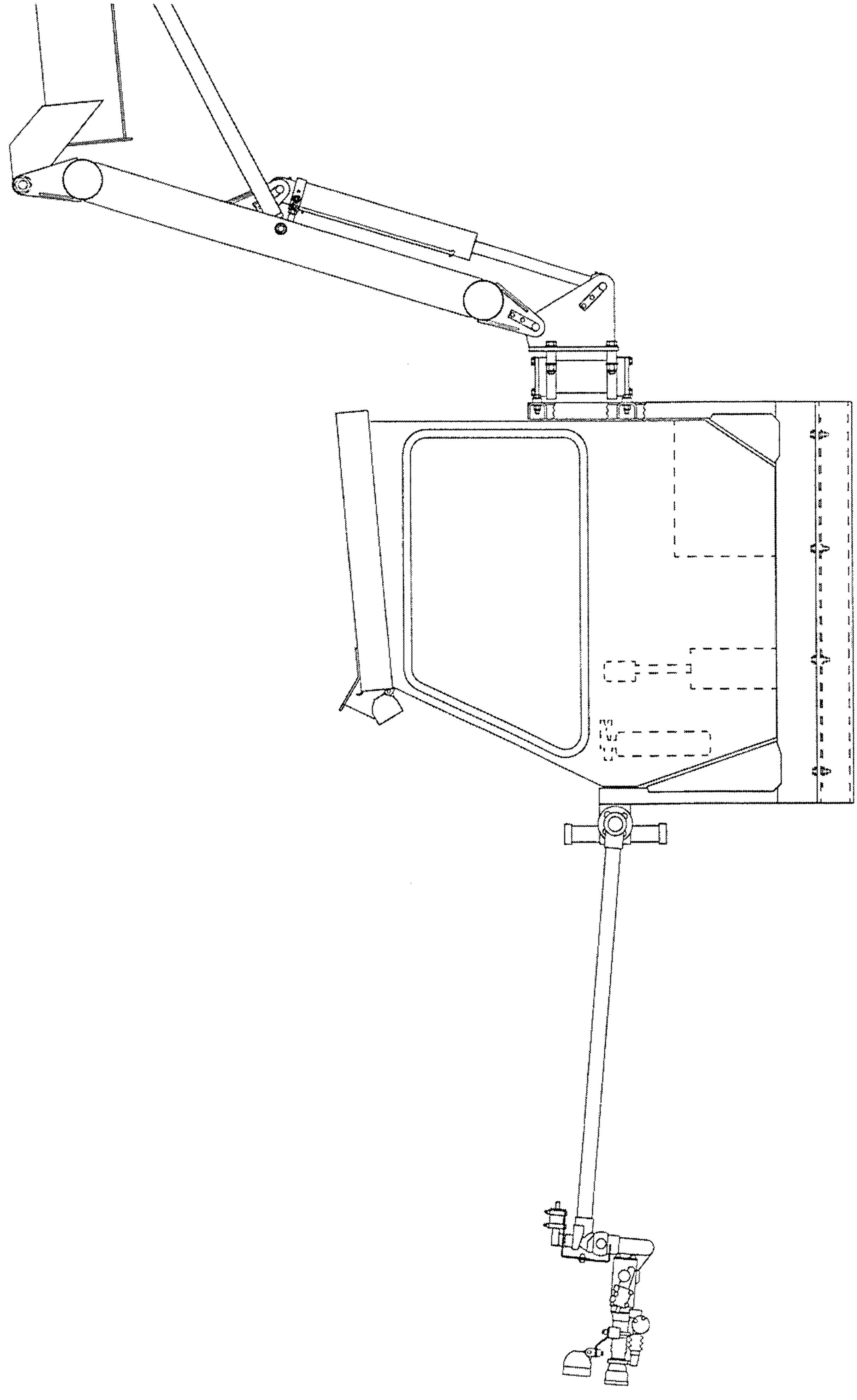
- *Compatible With Existing TM-1800 Deicers*
- *Utilizes Existing Tank Compartments in Main Fluid Tank*
  - *165 Gallon Capacity Is Standard*
- *Diaphragm Pump*
  - *Hydraulically Driven*
  - *Delivers 20 - 30 gpm @ 70 psi*

Enclosed Operator's Cabin Kits

- *Enclosure Protects Against Overspray and Blowback*
- *Heated With Fuel Fired Heater*
- *Seated Work Position Provides Increased Operator Endurance*
- *Removable Maintenance Platform*
- *Sliding Right Side Door Provides Easy Center Engine Inspection*

Enclosed Operator's Cabin Kits
(cont'd)

- *Nozzle Movement Provide by Mechanical Over Hydraulic System*
- *Removable Inside Panel Provides Accessibility to Electrical Components*
- *45 Degrees of Rotation Each Side of Center Provides Excellent Vision for Operator*
- *Windows on Four Sides for Better Viewing*
- *Laser System Provides Nozzle Aiming*
  - *Helps Minimize Fluid Waste*



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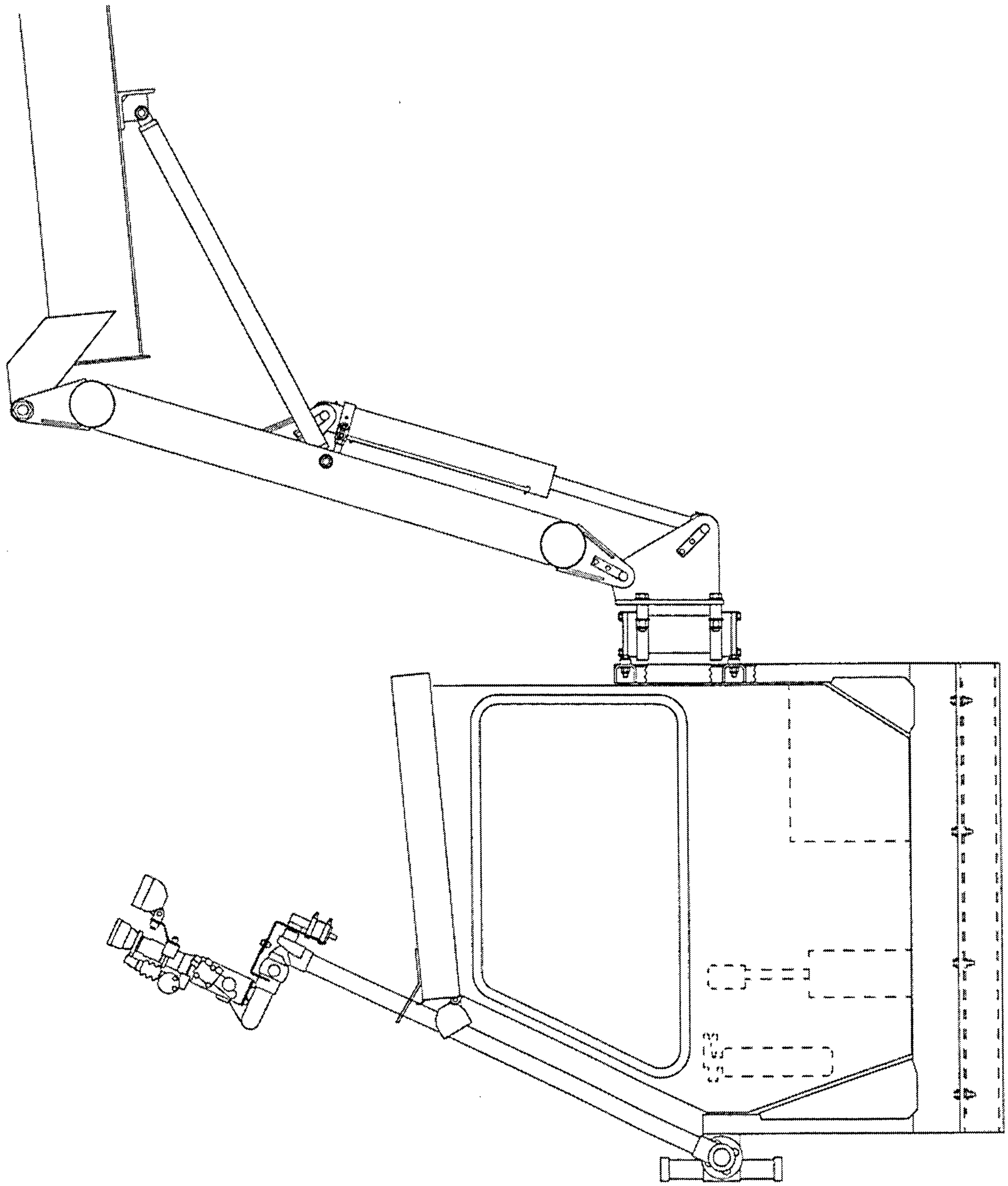
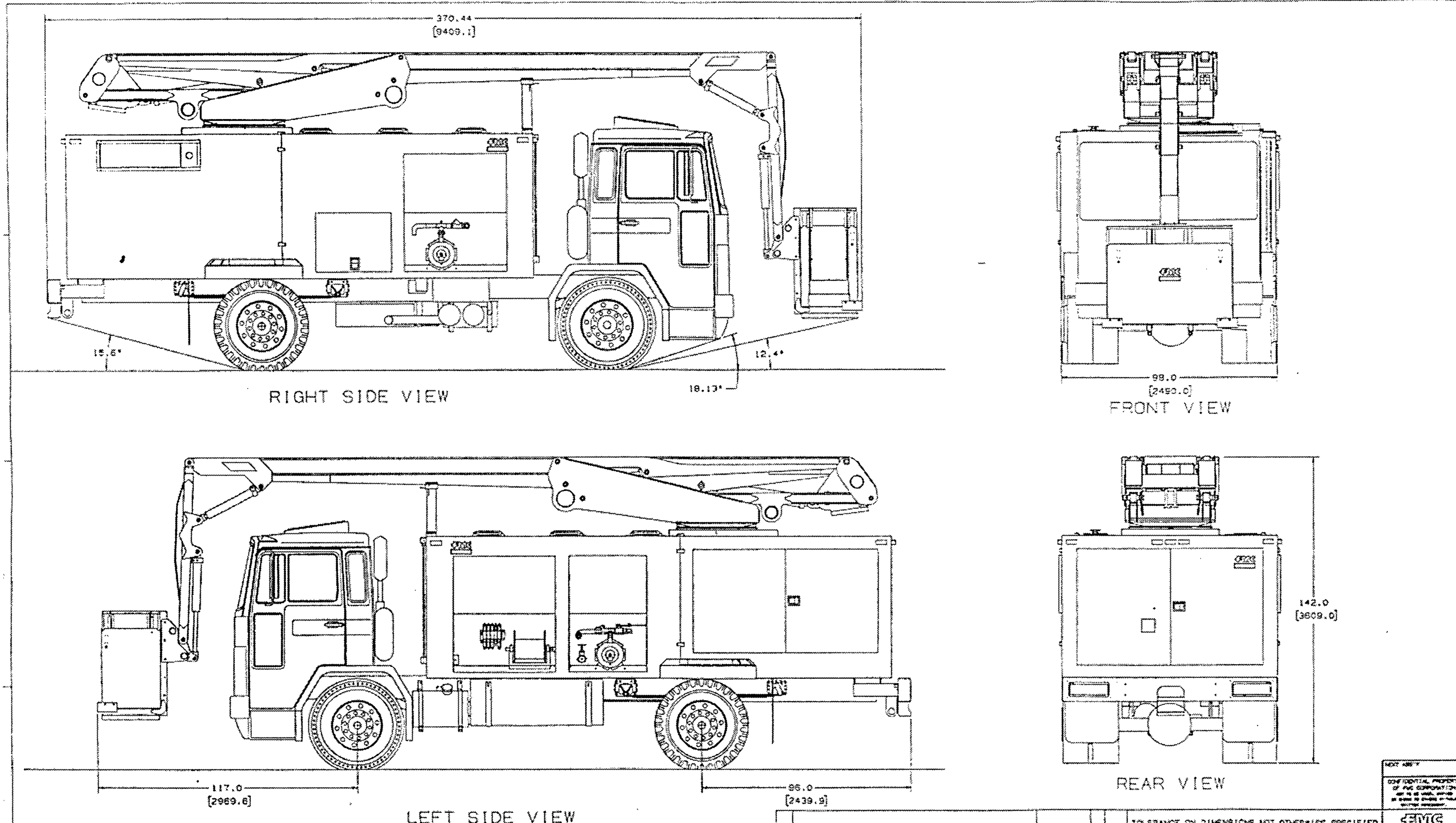


Modular Deicers

- Small and Large Capacity
  - 1200, 1500, And 2000 Gallon Models
- Commonality of Parts
  - Commonality Between Large and Small Deicers As Well As Commander 15 Loaders
- Capable of Mounting on Any Type of Chassis -- At Any Location
  - Deicer Can Be Completely Assembled, Tested and Shipped Without a Chassis

Modular Deicers *(cont'd)*

- *Corrosion Resistant, Easily Removable Aluminum Body*
- *Torsion Bar Provides Stability*
- *Optional Boom Height of 51 Feet*
- *Diesel Chassis and Heater Is Standard*
- *24 VDC Electrical System Voltage*
- *Ease of Maintenance and Operation*
  - *Minimized Pipe Thread Connections*



TOLERANCE ON DIMENSIONS NOT OTHERWISE SPECIFIED X.XX ± ±0.06 X.XXX ± ±0.030 ANGULAR ± ±2°	FMC CORPORATION ORLANDO, FLORIDA
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PRODUCTION RELEASE — A-XXXXX RL

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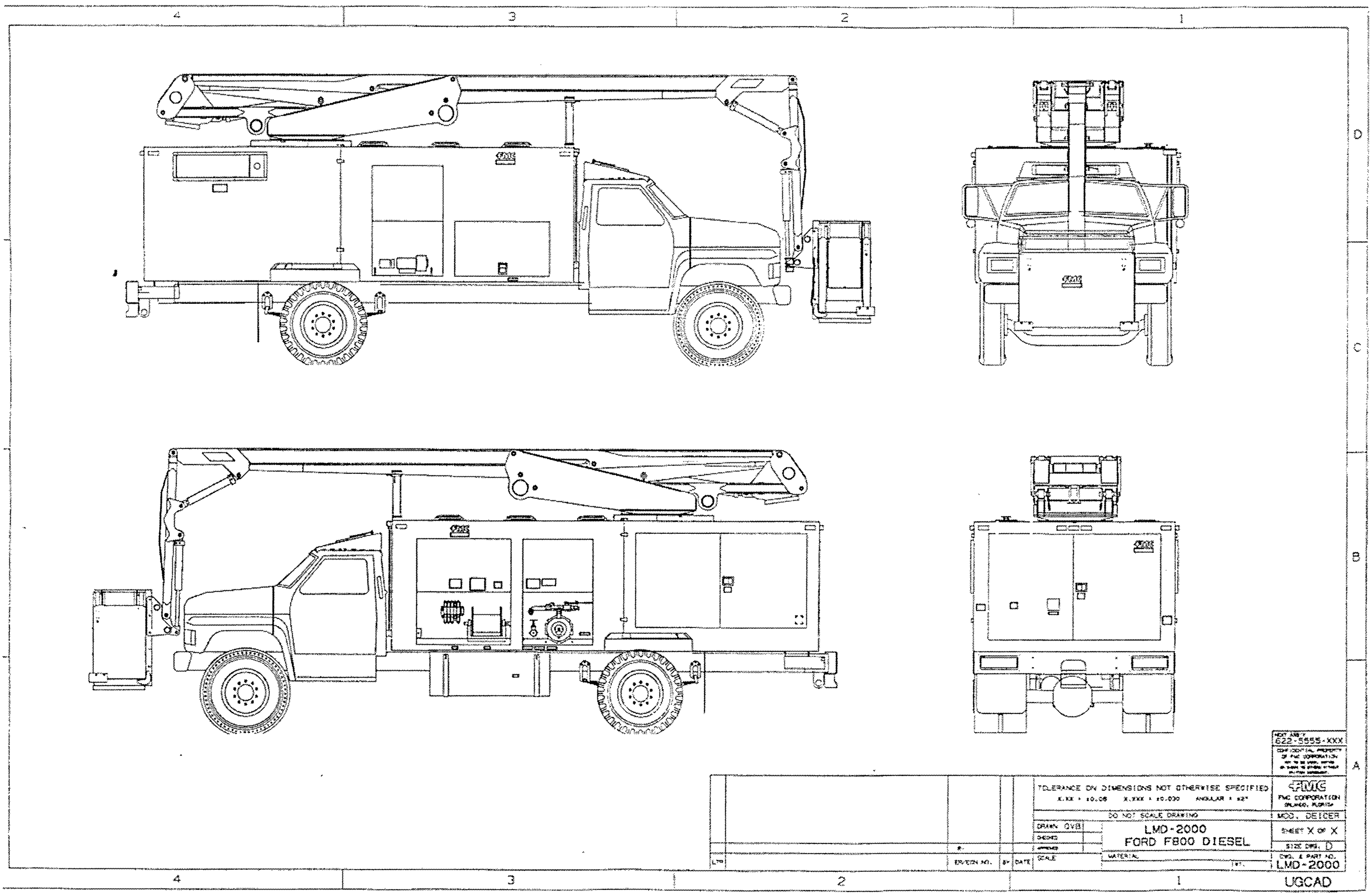

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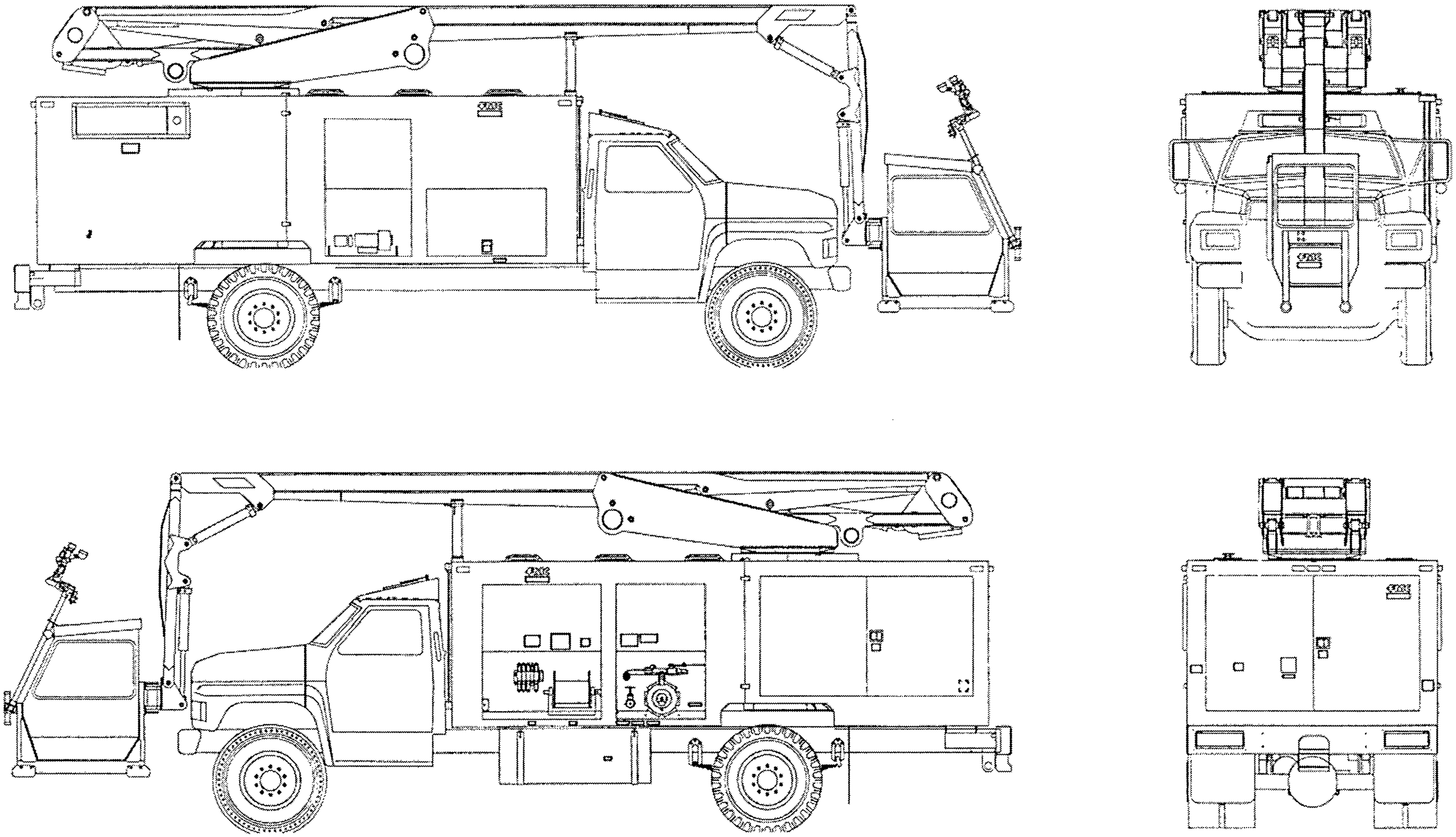

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SCALE

LMD-2000EC
FORD F800 DIESEL

MATERIAL

FMC
FMC CORPORATION
ORLANDO, FLORIDA

MOD. DEICER

SHEET X OF X

SIZE DWG. C

DWG. & PART NO. LMD-2000

LTR | ER/ECN NO. | BY | DATE

UGCAD

340

Forced Air

- Research
  - Done in Conjunction With U.S.A.F. Under a Co-operative Research and Development Agreement With Wright Laboratories at Wright-Patterson A.F.B.
- Testing
  - In Conjunction With Fed Ex and United Airlines
- Development
  - Improvements in Nozzle Design Has Enhanced Performance by Holding the Column of Air Tighter for a Greater Distance

Forced Air (cont'd)

- Non-Turbine Air Source
  - Subsonic Air Flow Reduces Noise
  - Easier, Less Expensive Maintenance

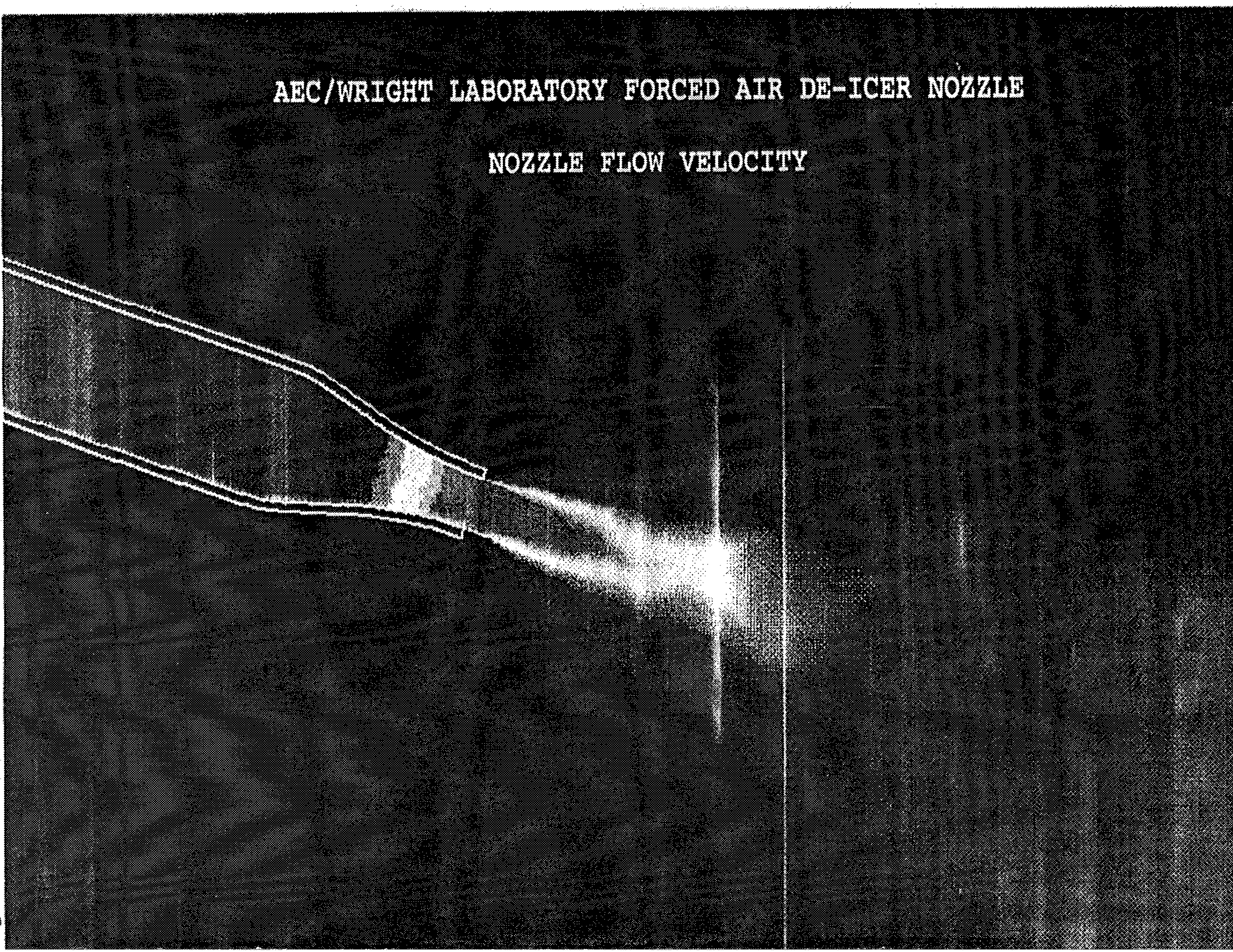
Results

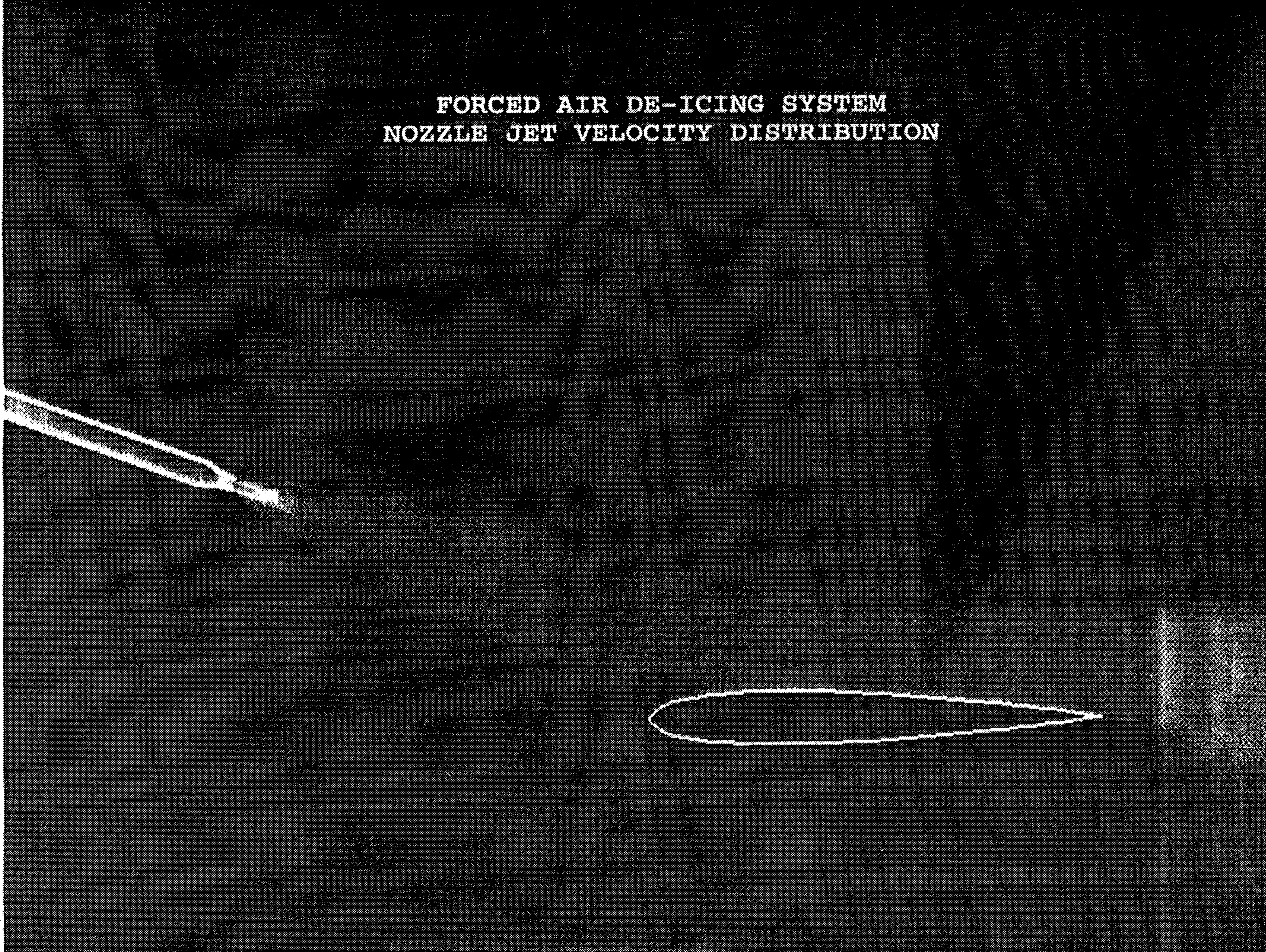
- As Much As 70% - 100% Fluid Savings
- 30% - 50% Time Savings
- Usability Has Been Expanded Beyond Dry Snow to Heavy Wet Snow and Frost
- Useful in Removing Ice and Snow From Ground Support Equipment, Containers, and Ramp Areas

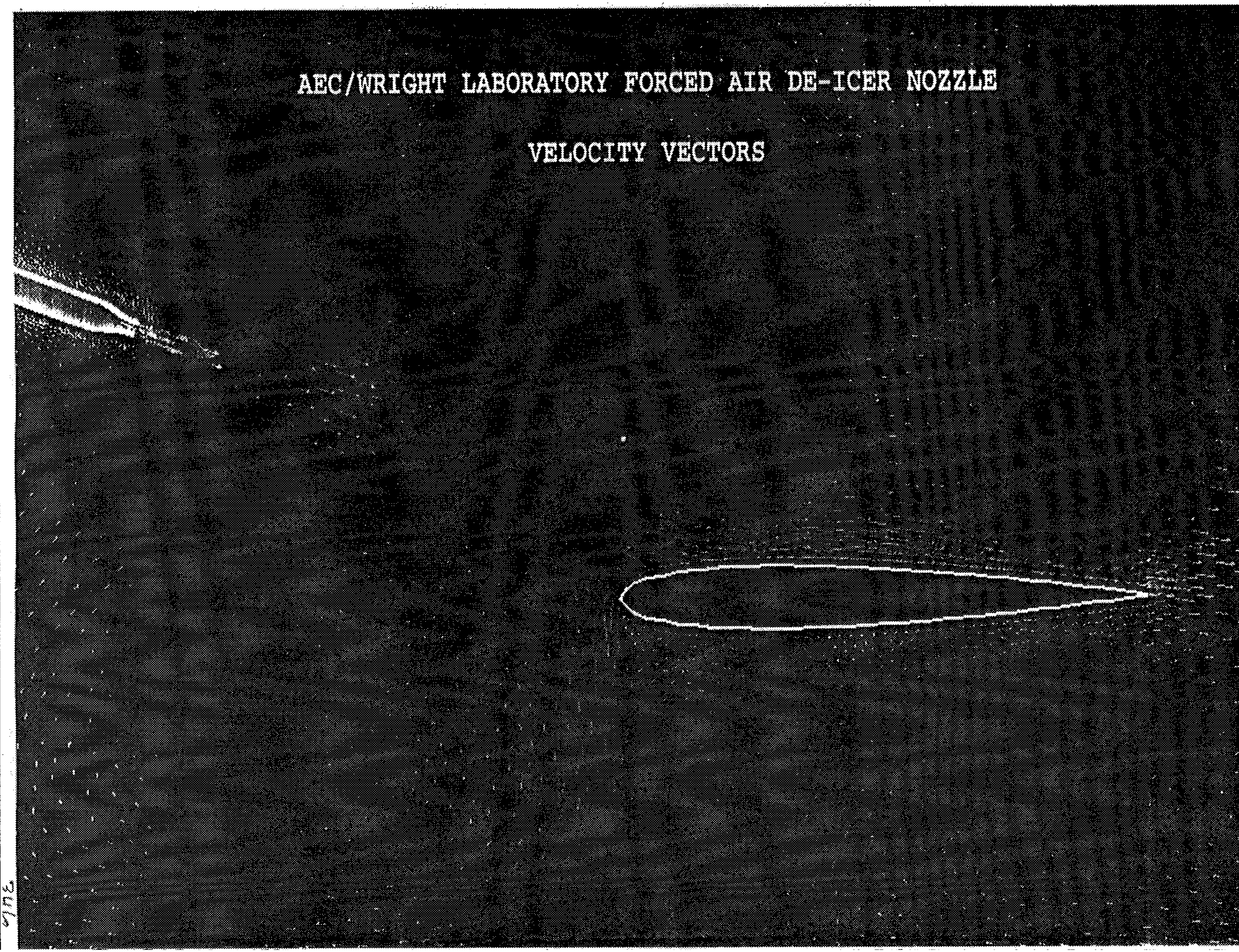
Forced Air *(cont'd)*

➢ *Modular Deicers*

- *Available As an Option in 1997*
- *Hydraulically Driven, "On Demand" Air Supply*
- *Provided As An Addition To Existing Deicing Fluid Systems*


AEC/WRIGHT LABORATORY FORCED AIR DE-ICER NOZZLE
NOZZLE FLOW VELOCITY


FORCED AIR DE-ICING SYSTEM
NOZZLE JET VELOCITY DISTRIBUTION


AEC/WRIGHT LABORATORY FORCED AIR DE-ICER NOZZLE
VELOCITY VECTORS

AEC/WRIGHT LABORATORY FORCES AIR DE-ICER NOZZLE

TEMPERATURE DISTRIBUTION

AlliedSignal Aerospace Equipment Systems
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AIRCRAFT DEICING

JOHN STANKO
PROJECT ENGINEER
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AIRCRAFT & AIRFIELD DEICING CONFERENCE
& DEICING TECHNOLOGY CROSSFEED

Washington, DC
August 18-21, 1996

Aerospace Equipment Systems (AES)

- AES (Torrance, CA) is owned by AlliedSignal
- AES makes aircraft air conditioning systems
  - commercial & military aircraft marketshare is 75%+
- Annual sales about 600 million
- AES's products include centrifugal-type air compressors
  - sister Engine division makes APUs
- AES's P3 compressor & Engine's 85 series APU are both ideal air sources for forced air deicing
  - both are mature & field-proven equipment

AES's AIR SOURCE

- Features of AES's P3 compressor
  - robust & compact
  - light weight
  - self-contained lube system
  - demonstrated reliability thru 35 yrs of aircraft service
- Compressor + hydraulic motor package
  - very rugged & compact
  - small installation footprint: 16"(W)x30"(L)x18"(H)
  - total package weight: 150 lbs.
  - produces over 100 ppm air @ 23 psi
- Easily mounted at base of truck or ground booms
  - simplifies air delivery system

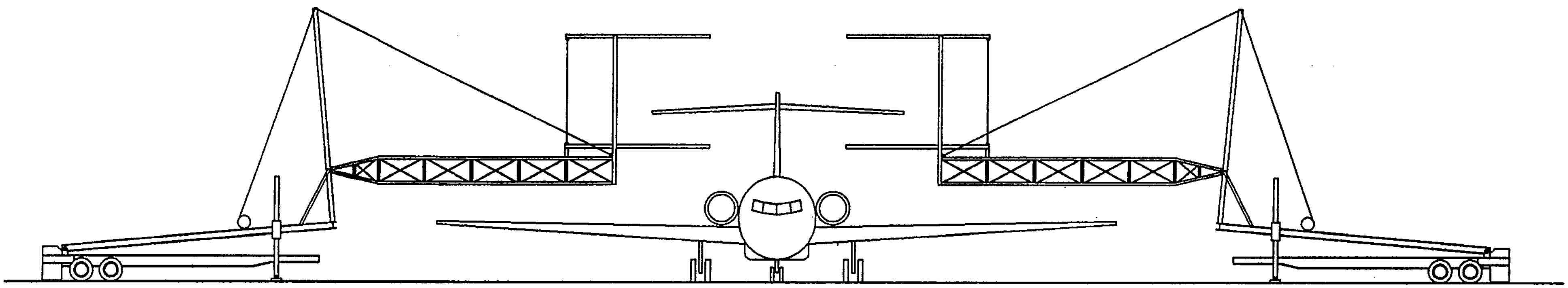
AES IS EVALUATING FORCED AIR

- We understand that pure forced air is limited
  - ineffective in many deicing conditions
  - heavy, wet snow & ice can't be handled
- Effort underway to add "punch" to air stream
  - AES approach marries two fluid flow technologies
    PATENT PENDING
- Our focus is in the following areas:
  - keep the system simple & robust
  - provide equipment familiar to deice operators
  - greatly reduce glycol consumption
    i.e. to 10% or less of current consumption
  - provide effective deicing
  - provide ease of operation & maintenance

AES DEICE DEMO TEST

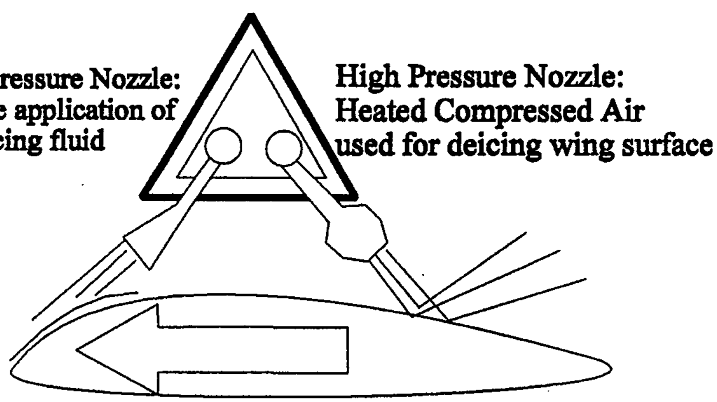
- Scheduled to begin after this Labor Day
- Test will be done at AES's laboratory
  - objective is to determine if it works
  - will include heavy snow & ice on test wing panel
- We understand that a successful test means
  - the first of several hurdles has been cleared
  - more work must be done

Whisper Wash™
Deicing /Anti-icing System



(U.S. Patent No. 5,104,068 ; Canadian No. 2,056,120, foreign and other patents pending)

Arm Cross Section



Features:
* Low Profile
* Adjusts to Aircraft Dimensons
* Rapid Set-up and Removal
* Deicing and Anti-icing in a single pass
* 70% savings in Glycol usage over Deicing Trucks
* Higher Thruput Capacity (~3x's) than trucks
* Dual use -- De-icing and Cleaning

For more information contact:

CCSI
Catalyst & Chemical Services, Inc.
2100 Muir Way, Bel Air, MD 21015
Phone: 410-569-1200 FAX:410-569-1202

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Vol. 1, No. 1

Weather, Wings, Wheels-up, and *Whisper Wash*™

Coming Soon to an Airport Near You !!

One-Step Deicing / Anti-icing System to Set New Standard

BWI will be the site of the Prototype Demonstration this Winter Deicing Season.

Fourteen years and $2 million after the inception of a new deicing system, Environmental Engineer John Gaughan will realize the completion of a tragedy-inspired invention.

New Technology for New Demands

"The Air Florida accident in 1982 was a wake-up call to the industry" says Mr. Gaughan, "Deicing truck technology was no longer adequate to meet the safety demands of increased traffic in inclement weather operations."

In the decade since then seven major and 162 minor wing ice related take-off accidents occurred, not including three runway "slide-offs" in the 1993-94 deicing season.
These accidents, along with the increased concern for the environmental damage caused by deicing operations provided the inspiration to continue during the uphill battle to change the industry's thinking towards off-gate (remote) deicing.

"*Whisper Wash*™ was designed to meet all three major concerns: passenger safety, processing speed, and protecting the environment" reports Mr. Gaughan, President of Catalyst & Chemical Services, Inc. (CCSI)

DOE, EPA, and Maryland support Key to Completion

The Maryland Energy Administration (MEA) contacted CCSI about the cost sharing grant program known as NICE3 which fosters energy efficiency and pollution prevention industrial projects. "MEA advice and support has been critical to our success which provided the much needed capital to finish the project." according to Mr. Gaughan whose firm contributed $1.6 million to the technology's development. "Their assistance put us over the top"

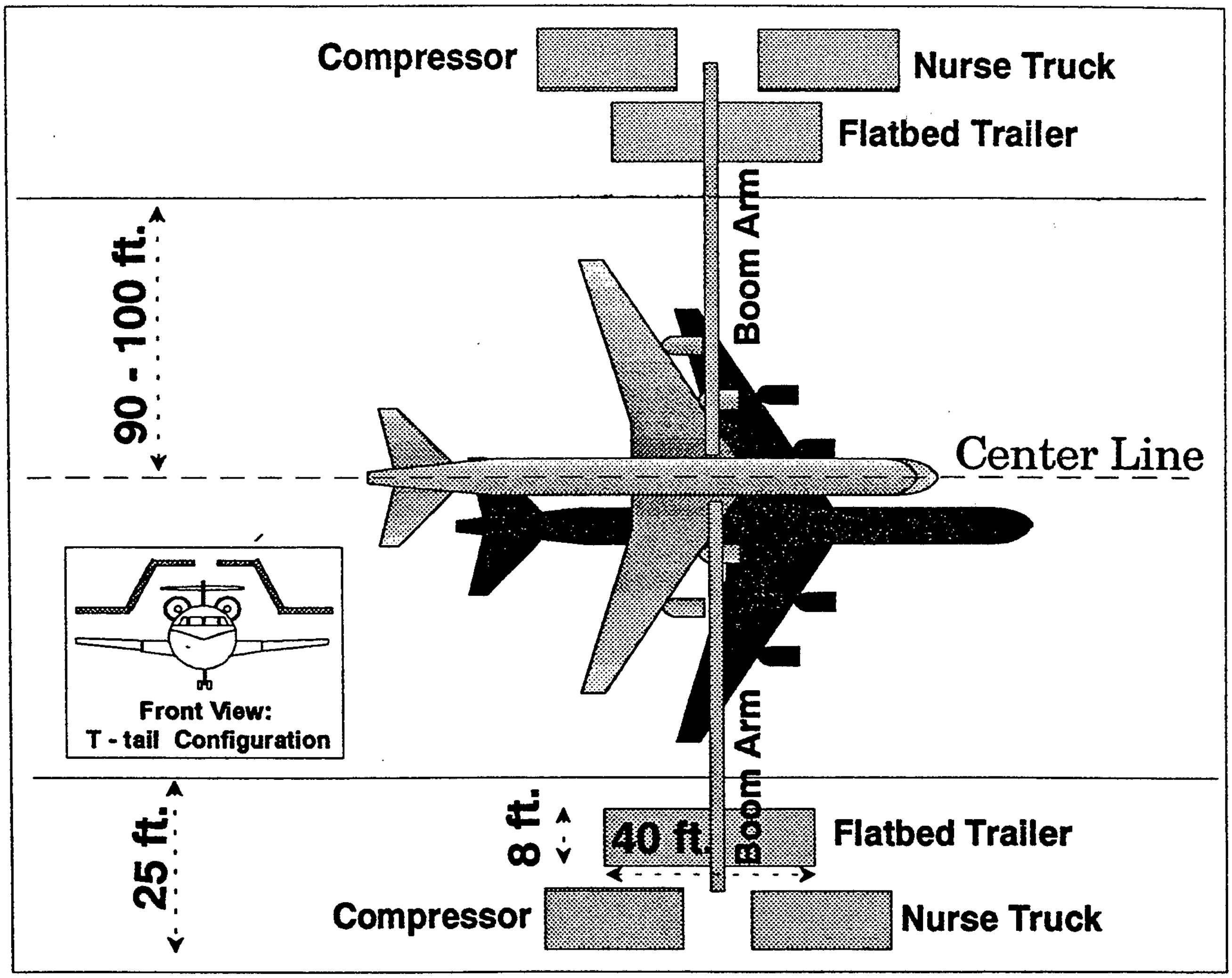
New & Improved

At this point, final construction and testing are underway with several improvements over the original tower design. Most notably, the "clamshell" chassis significantly lowers the overall profile of the equipment. This chassis design also improves the accuracy of the height adjustments for each aircraft and also has a locking failsafe feature in case of power loss. The placement of the equipment, cabling and counterweights allows the boom arm to be shortened by 15 feet. This reduces mechanical load (reduces "bounce") and allows for quicker set-up and disassembly times by only two ground crew personnel (i.e. faster response times to inclement weather events).

The double cantilever extensions at the end of the boom arms allow for greater deicing/anti-icing concentrations at the critical wing root and tail sections for an extra margin of safety. These improvements still carry the original advantages of (a) 70% reduction in glycol usage and (b) three times the thruput capacity of deicing trucks.

Whisper Wash™

Aircraft Deicing / Anti-icing System



Whisper Wash™ Typical Layout (Overhead View)

A multi-purpose mobile device which provides rapid, efficient aircraft deicing and anti-icing in a single pass. This patented device uses heated, compressed air for deicing immediately followed by a precise application of an anti-icing fluid These fluids can be either Type I, Type II, or aqueous based materials.

This same technology can be used to clean and rinse an aircraft during warmer weather thus providing all-weather utility and cost savings.

The *Whisper Wash* ™
Aircraft Deicing and Cleaning System
U.S. Patent #5,104,068

The ***Whisper Wash*** ™ is a drive-thru structure which both removes ice from an aircraft (deicing) and lays down a protective coating to prevent ice build-up on an aircraft prior to take-off (anti-icing). Both operations take place in a single "pass". An average 747 can be processed in under four (4) minutes and uses about 350 gallons of fluid. The structure is intended for use at a location remote to the departure gates and close to the end of runways, so that there is a short amount of time between treatment and take-off. Any excess fluid is collected and treated for possible reuse. The device is height, width and profile adjustable to accommodate all aircraft designs.

FLEXIBILITY

The actual system is mounted on flatbed trucks so that it can be moved into position and set up for deicing just prior to the arrival of an inclement weather event. After use, it can be disassembled and removed. The system can also be used to wash and rinse an aircraft during the warmer weather to enhance appearance and fuel efficiency.

The current technology are essentially fire trucks with "cherry pickers" attached that spray the anti-icing fluid (in most cases ethylene glycol --automobile antifreeze) on the aircraft; once to remove ice and a second time to prevent further ice build-up. This operation is perfomed at the gate. This technology is about 40 years old, uses about 2000+ gallons of fluid, takes about 20 to 30 minutes, and re-treatment is often necessary.

REDUCED OPERATING COSTS

Consequently, the use of ***Whisper Wash*** ™ technology can meet several objectives of any airport/airline by reducing operating costs associated with inclement weather operations and reducing delays associated with deicing.

ENVIRONMENTAL BENEFITS

In addition to the commercial benefits of updating deicing procedures, the environmental benefits are equally striking. Many states have issued studies which showed that the damage caused by deicing/anti- icing fluids to marine life around airports to be much greater and last much longer than anyone anticipated. It should be noted that the main components of deicing fluids, propylene glycol and ethylene glycol, are listed as non-toxic since they do not technically "poison" aquatic life. These fluids, however, absorb much of the Oxygen from the water in which they are dissolved; thus, suffocating aquatic life.

For this reason the EPA now mandates a clean-up and treatment program for spilled deicing fluids that nearly double the cost per gallon of using these materials. Replacement costs of a single deicing truck average about $250,000. Each airline at a major airport usually has 15 to 20 of these trucks (average lifespan 4 yrs.) with three to four replaced per year. The manpower costs are also at a premium because these people are often drawn from other emergency functions during inclement weather operations. Long-term liabilities for used glycol are difficult to anticipate but are significant when one includes costs associated with storage and treatment. The ***Whisper Wash*** ™ **technology eliminates these costs and liabilities for the airline companies.**

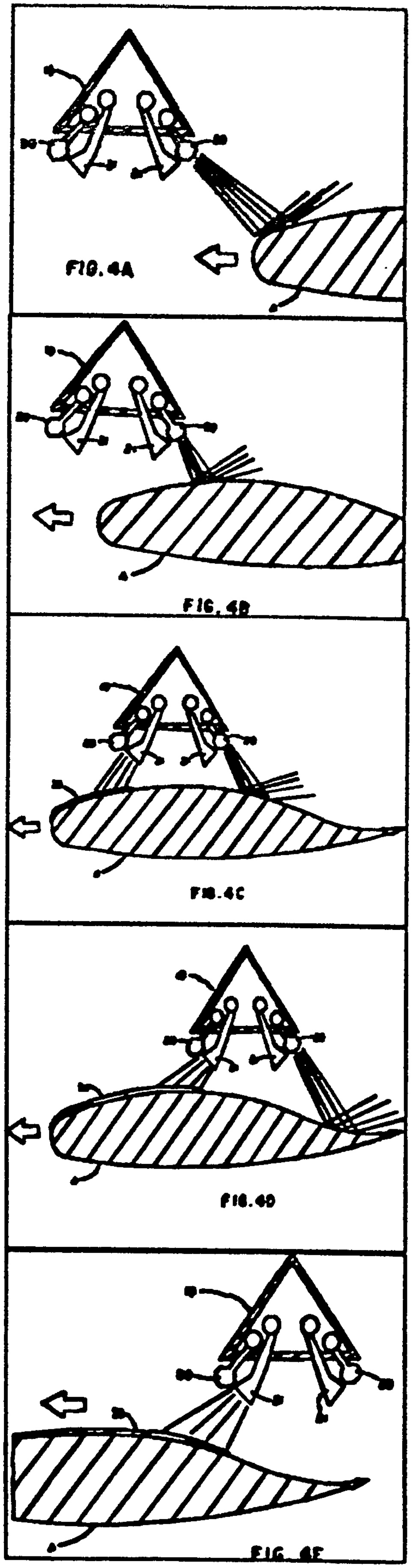
REDUCED MATERIAL COSTS

We are currently working towards the installation of the first commercial ***Whisper Wash*** ™ system. Based on field tests of prototypes, a commercial system is expected to reduce the use of glycol based deicing chemicals by up to 66% with 95+% of excess material recovered for recycling. This will have a major positive impact on an airports' ability to meet the NPDES Storm Water requirements (i.e. 40 CFR Part 122) as well as meet the newer FAA deicing requirements for Part 121 (commercial carriers) and Part 135 (regional carriers) as well as FAA Advisory Circular on the design of Aircraft Deicing Facilities (A/C 150/5300-14).

IMPROVED SAFETY

Despite all the operational, economic, environmental, and regulatory reasons that can be listed for the replacement of the current deicing procedures; the most compelling reason is safety. In the decade between the Air Florida crash in Washington (1/82) and the USAir crash in La Guardia (3/92), there were seven other major take-off accidents in which wing ice was cited as the cause (and five more in the decade prior to Air Florida's). In the 1993-94 deicing season, two planes slid off the end of the runways at Dulles, one in LaGuardia, and one in Cleveland for the same reason-- excess wing ice. FAA statistics from 1980 to 1990 show that there were a total of 162 reported icing accidents occurring on takeoff. Despite all the assurances of the aviation community, new technologies are clearly needed. It is for these reasons that the ***Whisper Wash*** ™ **technology has been developed and is being marketed by Catalyst & Chemical Services, Inc. of Bel Air, MD.**

Deicing and Anti-icing



BOTH steps in a single pass!

SAVES:
*Time
*Money
*Fluid
and the Environment

U.S. Patent # 5,104,068

PROCESS TECHNOLOGIES, INC.

PRESENTS

Infratek ™ Pre-Flight Deicing

to the

UNITED STATES AIR FORCE
ARLINGTON, VIRGINIA

21 AUGUST, 1996

Process Technologies Inc.

History

- Process Technologies Inc., an infrared, radiant energy gas research company
- Applied the latest patented technology to the application of aircraft pre-flight ground deicing
- *Both* cost effective *and* environmentally friendly.

Process Technologies Inc.

Technology

- Infrared radiant energy is applied through the use of patented energy process units
- Effectively deice aircraft without any negative impact on aircraft instruments, materials or occupants.

Process Technologies Inc.

Industry Acceptance

- FAA Washington, DC review of technology
- Referred to FAA Technical Center in Atlantic City
- Extensive laboratory evaluation of aircraft components
- Cooperative Research and Development (CRDA) agreement between Process Technologies, Inc. and FAA for further large scale evaluation

Process Technologies Inc.

Greater Buffalo International Airport

- Buffalo, New York
- Winter of '94 - '95
- Testing with FAA Convair 580 in accordance with CRDA terms
- Proved Viability of the Technology

Process Technologies Inc.

Greater Rochester International Airport (GRIA), Rochester NY

- Full scale demonstration, March 1996 (continues under CRDA)
- FAA Boeing 727-100
- InfraTek™ 2000 System installed on active taxiway,
- Alternative Technology Deicing Conference
  - 200 plus representatives from aviation industry worldwide

Process Technologies Inc.

InfraTek™ Rochester Airport Demonstration

Results

- Severe Icing (up to 3/16" thickness)
  - ◆ Melt observed in 30 seconds
  - ◆ Ice removed in 180 seconds
  - ◆ Complete deice and dry in 8 minutes
- Frost Conditions
  - ◆ Immediate melt during positioning of aircraft
  - ◆ 3 minutes to total defrost and dry
- System operating energy costs
  - ◆ Gas & electricity $93/hour (US)

Process Technologies Inc.

InfraTek™ System 2000 Cost

- For aircraft such as Boeing 727, 737 and up to Boeing 757
- Turnkey installation
- Cost $1.8 million (US) includes
  - training of operating staff
  - service & operation manuals
  - 24 hour service hotline support
- End user's responsibility to provide utilities to site

Process Technologies Inc.

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Inquiries to:

Process Technologies, Inc.
40 Centre Drive
Orchard Park, New York 14127

Phone: 716/662-0022
Fax: 716/662-0033

Process Technologies Inc.

U.S. Department
of Transportation
Federal Aviation Administration

Technical Center

Atlantic City Int'l Airport
New Jersey 08405

June 6, 1996

John Chew
Tim Seel
Process Technologies Inc.
40 Centre Drive
Orchard Park, NY 14127-4102

Dear John and Tim,

We have received and reviewed the *Preliminary Summary Report* which documents the aircraft deicing demonstration conducted at Greater Rochester International Airport during March.

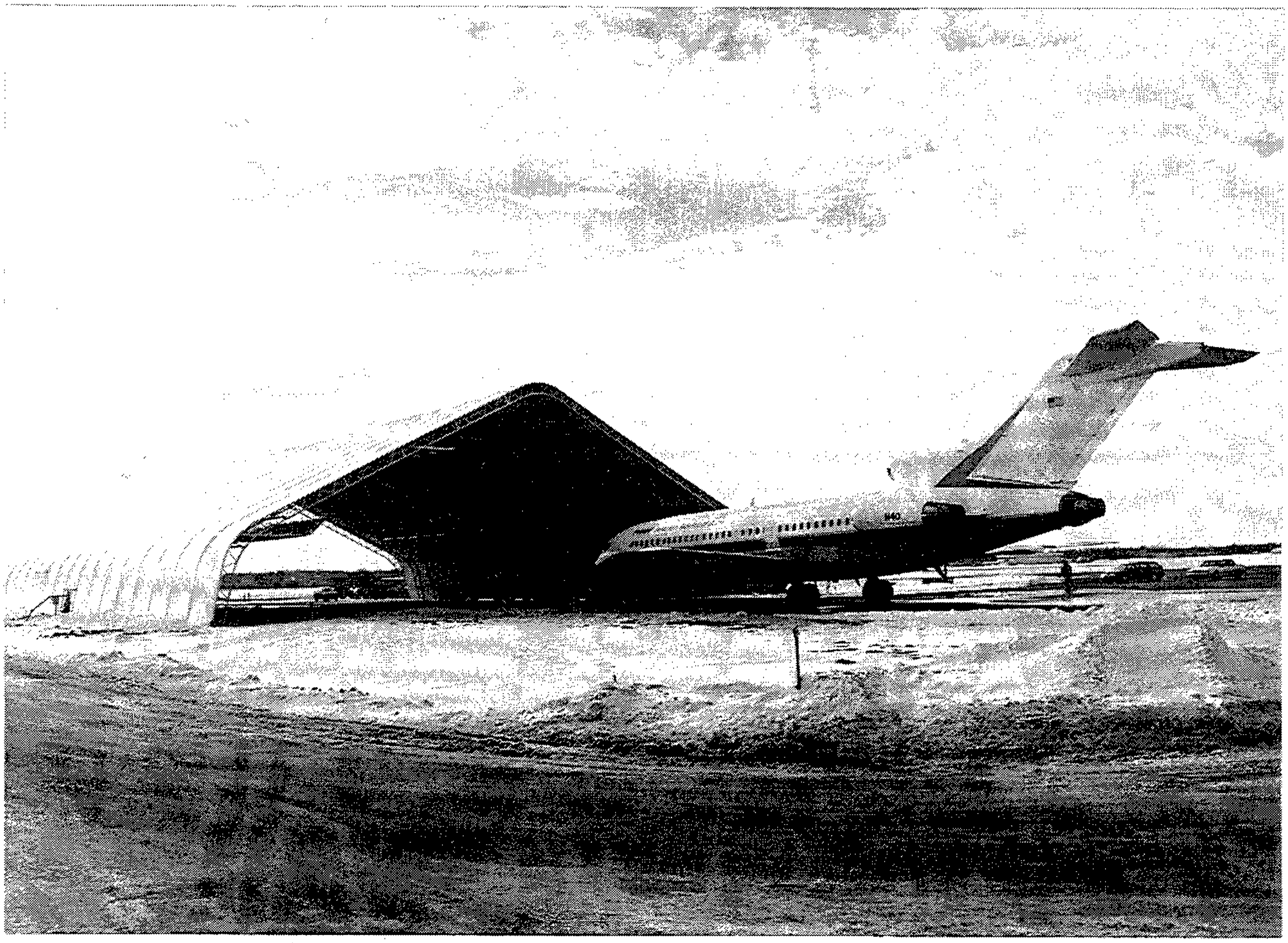
The report accurately records the major events and findings of the demonstration conducted with the FAA's Boeing 727 aircraft. The demonstration at Rochester indicated that the Process Technology Inc. infrared energy system exhibits the ability to remove ice and frost from exposed surfaces of an aircraft in a safe and efficient manner. We expect that a full report with recommendations will be available later this year.

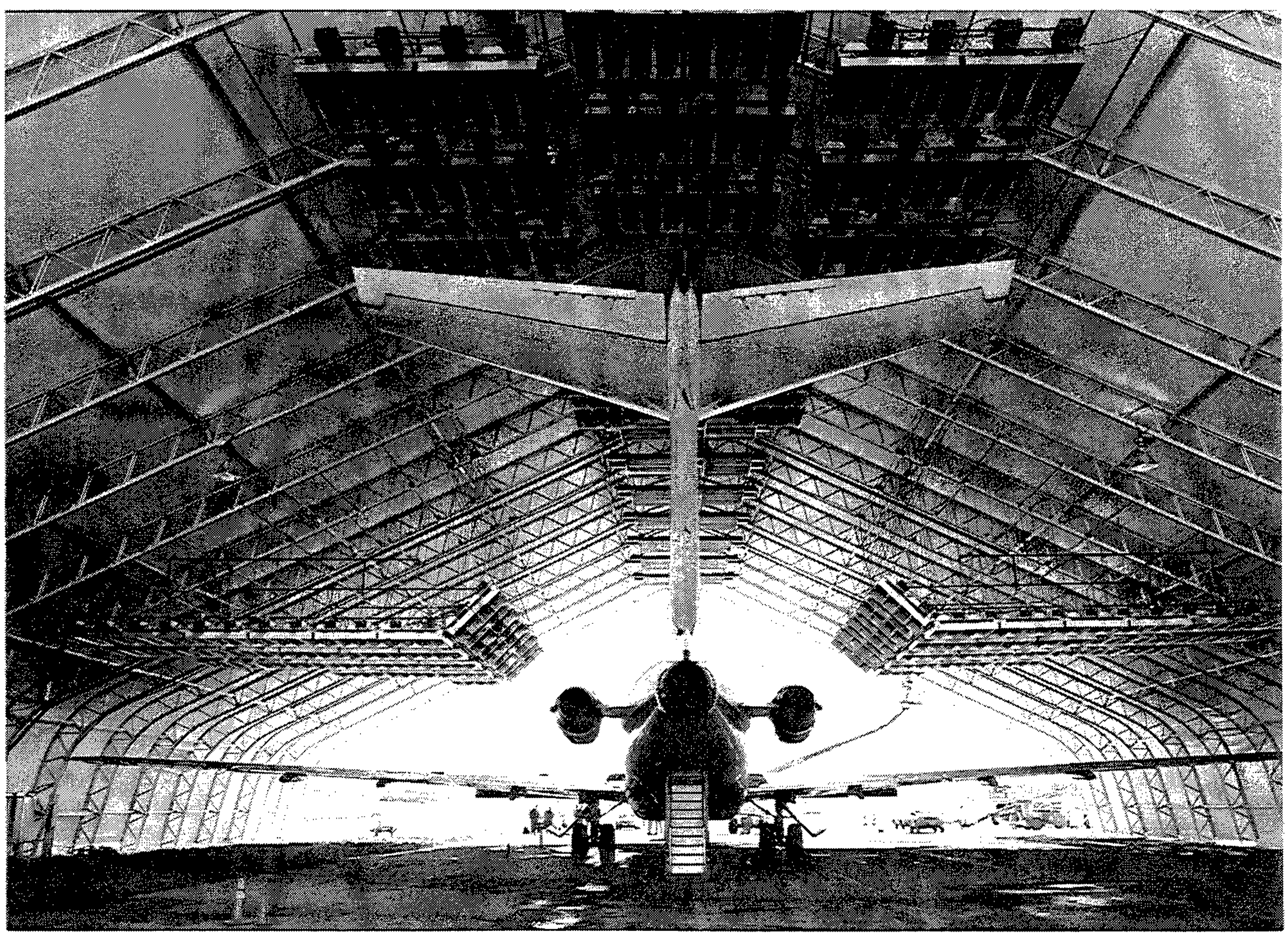
The Federal Aviation Administration's William J. Hughes Technical Center remains committed to continuing our partnership with Process Technologies Inc. under the terms of Cooperative Research and Development Agreement 95-CRDA-0077. As you know the role of the FAA in this partnership is to measure, observe, and provide resources that evaluate the advancement of a chemical-free method to deice aircraft. In this regard we suggest that you collaborate with other interested aviation parties to continue evaluations with a variety of aircraft and operational conditions in commercial applications with airline involvement. Towards this end we encourage you to distribute the *Preliminary Summary Report* to selected parties on a need-to-know basis.

Please contact me at 609 485-5138 if you have any questions or concerns on this issue.

Sincerely,

Jim White, Principal Investigator
Airport Technology R&D Branch, AAR-410





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InfraTek™ Pre-Flight Deicing System

Process Technologies Inc.

July, 1996

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Enclosure A

Major Components of the InfraTek™ System 2000

The basic **InfraTek™** System 2000 includes as a minimum, the following component systems, equipment and labor:

- InfraTek facility, sized for 757 and similar narrow-body aircraft , completely erected on site with lighting, electrical and gas distribution systems included.
- Energy Process Units (EPU) mounted in banks of 4 individual burners depending on the aircraft layout agreed upon. Each individual EPU is fired by natural gas. Total number of EPU units is determined by aircraft fleet serviced. Each EPU runs on 120 VAC, and has a connected load of approximately 1 amp.
- Electrical distribution and control panel as necessary for equipment installed in the system. Supply voltage required is 120/240 VAC single phase, 60 hz.
- Gas safety and control valving as necessary for equipment installed in the system.
- All labor, whether provided through local sources or through PTI, to erect the Clamshell structure, install the electrical and gas distribution system in the structure, install and commission the EPU units. Labor to be per allowances established in the contract.
- Training to airport personnel (for a maximum of three days) on the operation, maintenance and troubleshooting of the structure, the EPU units and related systems.
- Access to 24 hour support from PTI technical service personnel.
- Operating manuals and documentation for all mechanical, electrical and system components of the InfraTek system.
- 1 year complete warranty on all components.

BUYER responsible for the following:

- Gas utility hook up and supply piping to the facility. Minimum 2 psi service pressure required.
- Electric utility hook up and supply to the structure control panel.
- Operation labor for the system.
- Permits and other regulatory agency compliance documentation and approvals.
- Obstruction and demarcation lighting, if required.
- Site preparation and foundations.
- Airfield Security during installation, commissioning and operation.

Process
Technologies
Inc.

Enclosure B

InfraTek™ System 2000 Specification

1. GENERAL:
   1.1 The system facility shall be a frame supported, tension fabric structure of modular design, providing unobstructed area for aircraft access.
   1.2 The system facility shall have fabric panels which can be removed from ground level with the structure erected and operational, without affecting the structural integrity of the structure.
   1.3 The system shall incorporate high output infrared devices specifically designed for deice operations.
   1.4 The system shall include all necessary control systems for safe and efficient operation.

2. SPECIFICATIONS:

   2.1 Facility

   2.1.1 Dimensions:

   2.1.1.1 The structure shall have external dimensions as follows: Width: 166 ft. Height: 56 ft with an eave height of 17 ft. Length: 208 ft. The structure shall consist of thirteen 16 ft long bays.

   2.1.2 Structure Operational Characteristics:

   2.1.2.1 The structure shall withstand steady winds of 90 miles per hour as assessed under the criteria of the U. S. Metal Buildings Manufacturers Association with the recommended Aluminum Association Safety Factor of 1.95.

   2.1.2.2 The structure shall have an operational service range of -20° to +160° Fahrenheit.

   2.1.2.3 The minimum structure life span of frame components shall be thirty (30) years. Fabric coverings of the structure are have a minimum service life of seven (7) years .

   2.1.2.4 The structure shall be erected on a concrete surface prepared per facility manufacturer's recommendations.

   2.1.3 Installation/Disassembly:

   2.1.3..1 The structure shall be capable of being erected/struck by ten-to-twelve untrained persons in four weeks, or less.

   2.1.3.2 The structure shall be capable of being erected/struck in wind speeds up to twenty-five (25) miles per hour.

   2.1.3..3 The structure will require cranes and manlifts with 60 foot minimum height reach for assembly.

Process Technologies Inc.

2.1.3.4 Concrete footings, or a concrete tarmac, suitable to withstand reaction loads provided by the facility manufacturer and local code requirements shall be provided at each arch termination point.

2.1.4 Materials:

2.1.4.1 Weather Barrier Fabric:

2.1.4.1.1 The fabric shall be a laminated PVC fabric of sufficient weight and strength to meet the performance characteristics required of the structure and subject to the following minimum requirements.

2.1.4.1.2 The fabric shall have a minimum tear strength of 120 pounds in the warp and fill directions per FED-STD-191 Textile Test Methods, Test Method 5134.1.

2.1.4.1.3 The fabric shall have minimum tensile strength of 400 pounds in the warp and fill directions per FED-STD-191 Test Method 5100.

2.1.4.1.4 The adhesion of coating on the face side of the fabric shall have a minimum adhesion of 10 pounds per two (2) inch strip.

2.1.4.1.5 The fabric shall be UV stabilized in high and/or low humidity conditions.

2.1.4.1.6 The fabric shall not be susceptible to rot or mildew.

2.1.4.1.7 The fabric shall be flame resistant per NFPA 701 criteria.

2.1.4.1.8 The fabric shall remain serviceable in temperatures from -20°F to +160° Fahrenheit for the life of the structure without tearing.

2.1.4.1.9 The color of the fabric shall be White/White or Ivory/White. Weight to be 24 oz. -0 + 2 oz.

2.1.5 Frame:

2.1.5.1 The frame shall be constructed of 6061-T6 aluminum alloy to U. S. Fedaral Spec. QQ-A-200/8 (equivalent to MIL-E-16053 and ASTM-B221).

2.1.5.2 Interchangeability/Modularity - Structure components shall be such that like components can be exchanged within or between structures.

2.1.5.3 Channels - The frame shall have channels which have provisions to accept both inner and outer tensioned fabric panels. The channels shall be smooth and allow the fabric panels to pass through them unobstructed.

2.1.5.4 Purlins shall be located on the inside of the fabric/weather barrier.

2.1.5.5 The structure shall have an aluminum rain gutter attached to the bays into which weather barrier panels clip, thereby providing a water control system.

2.1.6 Personnel Doors (optional):

2.1.6.1 Single personnel doors shall be provided at customer designated bays along the sides of the structure.

2.1.6.2 Single personnel doors shall be of heavy duty construction.

2.1.6.3 The personnel doors shall have minimum dimensions of 3'-0" wide x 6'8" high.

2.1.7 Support Systems :

2.1.7.1 Electrical Power Distribution:

2.1.7.1.1 A weatherproof, power distribution panel shall be provided for controlling electrical operations .

2.1.7.1.2 All controls shall be clearly marked.

2.1.7.1.3 The electrical system shall conform to the current National Electrical Code.

2.1.7.2 Lighting:

2.1.7.2.1 The lighting system consists of five (5) harnesses, each with two Hi-Bay light fixtures. Lighting provided shall provide 20 F.C. minimum @ 36" above the floor.

2.1.7.2.2 Lights shall be capable of being installed and secured from the ground before the framework is raised into its vertical position.

2.1.7.2.3 Lights shall be provided with pre-wired harness for ease of installation.

2.1.7.3 Anchoring:

2.1.7.3.1 The anchoring system shall secure the structure during steady wind loads of 90 mph.

2.2 Energy Process Units

2.2.1 The Energy Process Units (EPU) shall be an unvented forced draft high output infrared radiant process burner designed for aircraft deicing. Total output should be sufficient for fast and economical deice operations.

2.2.2 The EPU units shall be suitable for operation in altitudes to 2000 feet above sea level without adjustments. Above 2000 feet above sea level operation with appropriate orifice jet adjustments should be possible.

2.2.3 The EPU units shall be capable of being fired with Natural and Propane gas.

2.2.4 The EPU Units shall be constructed according to methods listed in the following approval standards:

ANSI Z83.6-1990	Gas-Fired Infrared Heaters
ANSI Z83.6a-1992	Addenda to ANSI Z83.6-1990
ANSI Z83.6b-1993	Addenda to ANSI Z83.6-1990
ANSI/NFPA Article 70	National Electric Code
CAN1-2.16-M81	Gas-Fired Infrared Heaters and Interim Requirement No. 24, Tube Type Radiant Heaters
CAN/CGA-2.17-M91	Gas-Fired Appliances for Use at High Altitude
CAN1-2.21-M85	Gas-Fired Appliances for Outdoor Installation
CSA C22.2 No.0-M1991	General Requirements-Canadian Electric Code, Part II
CSA C22.2 No.3- M1988	Electronic Features of Fuel-Burning Equipment

2.2.5 EPUs Units shall be installed according to methods listed in the following approval standards:

ANSI Z223.1-1992/(NFPA 54)	National Fuel Gas Code
ANSI/NFPA Article 70	National Electric Code
CAN/CGA B149.1 and B149.2	General Installation Codes
CSA C22.2 No.0-M1991	General Requirements-Canadian Electric Code

2.2.6 EPU Unit electrical rating shall be as follows:

Standard Equipment:	120 VAC; 60 Hz; 1.3 Amps; 1 Phase (North America)
Optional Equipment	220-240 VAC; 50 Hz; .7 Amps; 1 Phase, Phase-Neutral System (Europe)

2.2.7 EPU Unit gas pressure ratings shall be as follows:

Minimum Supply Pressure:	Natural Gas - 5.0" W.C.
	Propane Gas - 11.0" W.C.
Manifold Pressure:	Natural Gas - 3.5" W.C.
	Propane Gas - 10.5" W.C.

2.3 Auxiliary Equipment

2.3.1 The facility shall be equipped with a breaker type electrical distribution panel which accepts power from local utilities and distributes it to EPUs, lighting and accessory outlet connections according to local code requirements. The load rating of the panel shall be sufficient to accommodate EPUs and Support Equipment.

2.3.2 Integral lighting fixtures shall be provided to supply a minimum 20 foot-candles illumination at a level 3 feet above finished floor within the facility. Typical fixtures are of the 1000 watt, metal halide variety.

2.3.3 The facility shall be capable of distributing gas from local utility sources. Both high pressure (2-4 psi) and low pressure (1/2 psi or less) distribution systems shall be accommodated. Metering and safety relief outside the structure shall be according to local code requirements.

2.3.4 Connection between the gas distribution piping and the EPU bank distribution piping shall be provided via flexible, corrugated stainless steel tube wrapped in PVC. Flexible tubing shall be approved for use according to a variety of standards including the Canadian and American Gas Associations.

Enclosure B

3. WARRANTY:

Process Technologies, Inc. (PTI) warrants that the equipment delivered hereunder will be free from defects in workmanship and will conform to applicable specifications invoked in this agreement. Subject to the limitations set forth below, PTI agrees to replace or correct within a reasonable time frame and without expense to the Buyer any materials not conforming to the foregoing requirements when notified by the Buyer thereof during a period of 12 months after delivery. Materials returned to PTI for repair/replacement must be so authorized by PTI prior to shipment back to PTI.

This warranty excludes consumable parts, such as hardware, bulbs, fuses, etc., during the warranty period.

Failure of the Buyer to properly complete all pre-installation and installation requirements, system test requirements and maintenance procedures as required by PTI via technical, operational or maintenance manuals shall release PTI from all of its obligations as herein provided.

The foregoing warranties are exclusive and in lieu of all other warranties, whether express or implied, including any warranty of merchantability or fitness for a particular purpose. Failure of the Buyer to promptly notify PTI of any such non-conformity shall release PTI form all of its obligations as herein provided. Further, any repairs or alterations to the equipment by the Buyer not authorized by PTI in advance shall release PTI from its warranty obligations. Any defects or damage resulting from abnormal use, misuse, abuse, or normal wear and tear are not covered under this warranty and shall be the responsibility of the Buyer.

This warranty applies only to the extent that any equipment or process furnished hereunder is in accordance with PTI's goods regularly sold and not (a) supplied according to Buyer's design or instructions; (b) modified to meet particular needs of the Buyer; or (c) combined by Buyer with items not furnished hereunder, where such design, instruction, modification or combination is responsible for the warranty claim. The foregoing states the entire liability of PTI with respect to warranty.

WARRANTY (applicable to services rendered):

PTI warrants that any service rendered hereunder will meet professional standards and will conform to all requirements of this Order. PTI agrees that it will, within a reasonable time frame, correct or reperform without expense to the Buyer any services which do not meet such requirements when notified by the Buyer within a period of 12 months after performance of such services. The remedies provided hereunder are exclusive, and no other warranties, either express or implied, are applicable.

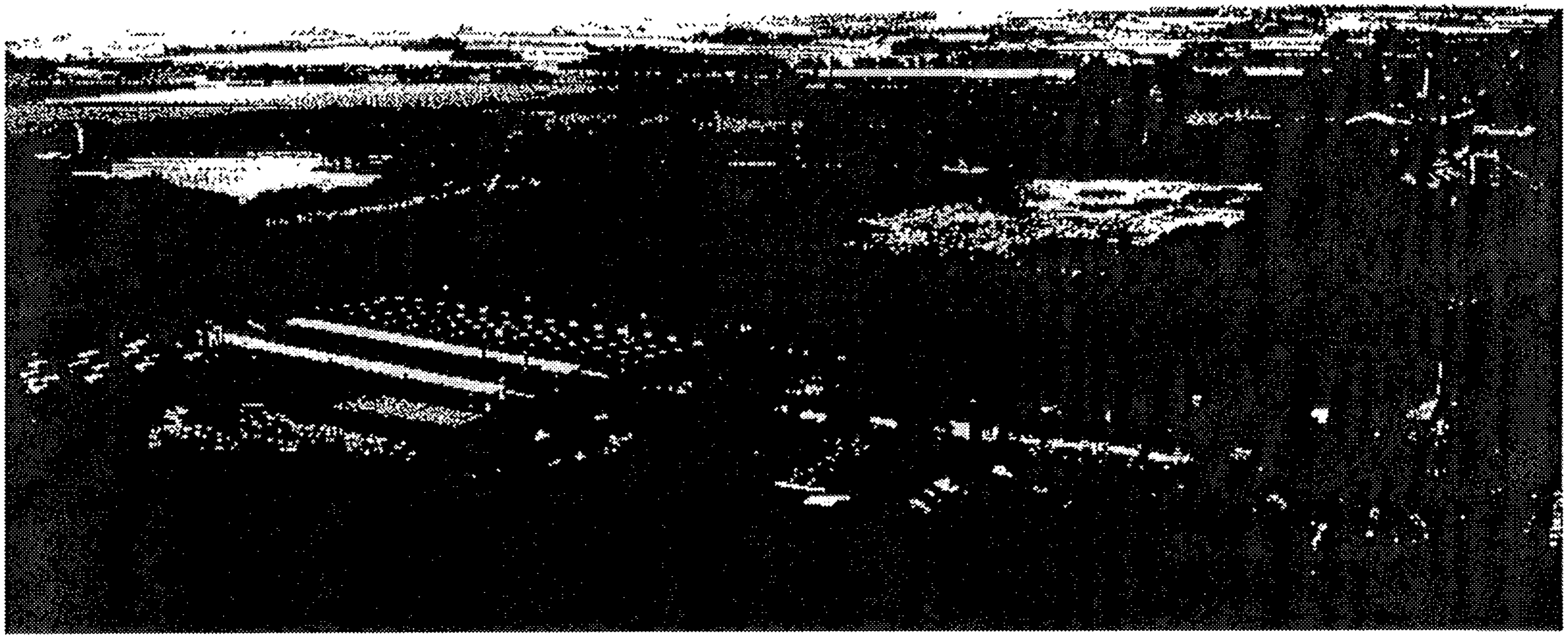
epoke®

Efficient Pre-Moist Chemical spreaders

De-icing Technology Crossfeed ANSER - U.S. Air Force
August 20-21, 1996 in Arlington, Virginia

epoke®

Epoke A/S, Denmark, 1996



- Main figures
  - 230 employees
  - and 55 employees in 4 subsidiary companies
  - 13.500 m2 production facility in Danmark
  - Total sales approx. DKK 150 mio.
  - Export share 75%

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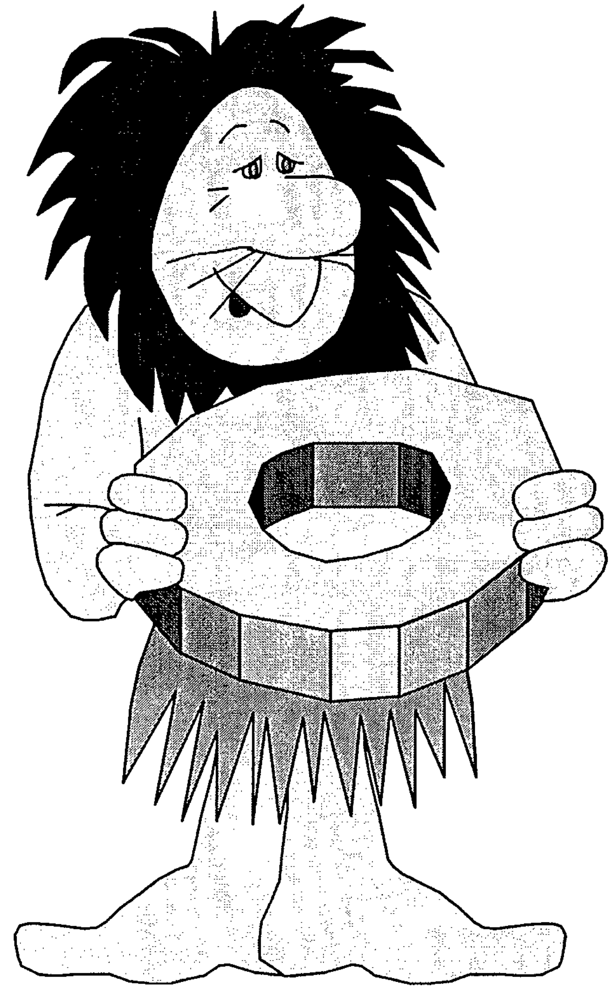
epoke®

History in brief

- <u>1930 ies.</u>
  - Ole Christian Thomsen, district engineer- at Ribe Amts Vejvæsen (Ribe County Road Administration), invents the sewer cleaner and a sand spreader with spreading disc.

- <u>1950 ies.</u>
  - Alfred Thomsen invents the roller princip (Epoke princip) and establishes the production plant in Aaskov.
  - In 1956 the first dealer agreement is signed with Grindvold in Norway

- <u>1990 ies.</u>
  - Epoke is now owned by the 3. generation
  - Export now to more than 25 different countries
  - 100.000 Epoke spreaders now in operation all over Europe, Canada and in the USA.
  - Subsidiary companies in Germany, Sweden, France and in the USA



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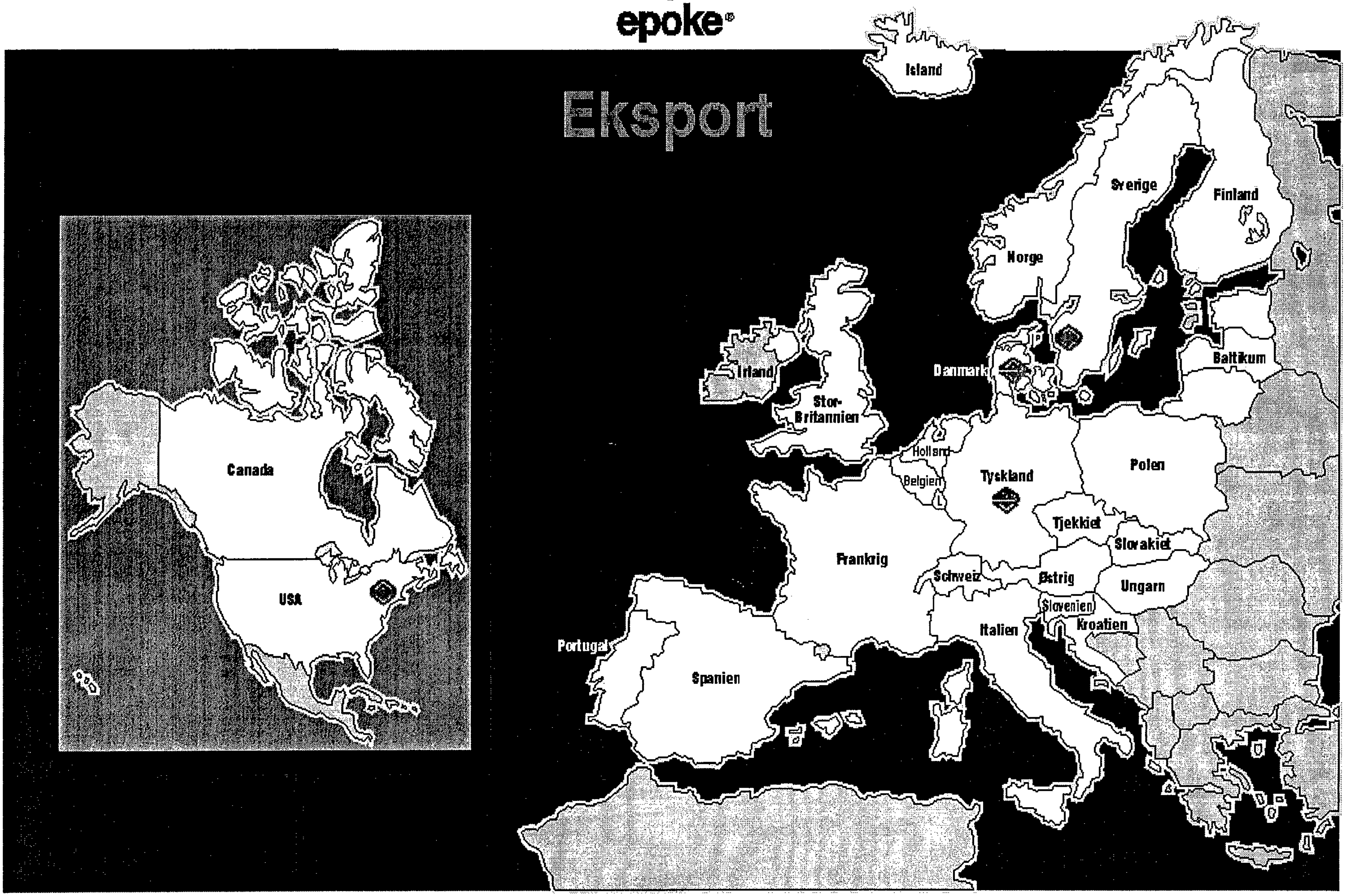
epoke®

Eksport



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epoke®

Product development since 1980

Bodö Nato Airport, Bodö, Norway	P 60 H	1980
Schiphol Airport, Amsterdam, Holland	PWB 52 2T	1980
Forsvarets Materiel Värk - Danish Military Airports in Värlöse, Tirstrup, Karup and Skrydstrup, Denmark	PWB 58 2T	1982-1983
Fuhlsbüttel Airport, Hamburg Germany	PB 2T 67 H	1983
Bodö Nato Airport, Bodö, Norway	PB 2T 70 HD	1985
Langenhagen, Hanover, Germany	PWV 87 HKD SH 2000	1993 1994
Forsvarets Materiel Värk -Danish Military Airports in Tirstrup, Denmark	PWV 87 HKD	1995
FMV Forsvarets Materiel Värk, (Swedish Military Airports in Luleå, Østerssund, Såteness, Uppsala, Säve, Ângelshol, Söderhamn, Eskildstuna, Lindköping, Ljunbyhed, Rönneby, Hultsfred, Sweden	SH 4515 2T Runway Combi	1995 - 1996
Billund Airport, Denmark	SE 4515 2T Runway Combi	1995

The above is only some of our european customers

epoke®

MOST COMMON RUNWAY DE-ICERS IN EUROPE

MANUFACTURER	PRODUCT	DETAILS	Recommended quantities	Recommended quantities
Various	Sand		(150 g/m2)	
Various	Urea	Nitrogen, Solid de-icer	Anti-icing 20 g/m2 De-icing 40g/m2	7,6 O. /FT.2 15,2 O/FT.2
Various	Glycol	Liquid de-icer		
BP Chemicals, England	Clearway 1	Liquid de-icer based on potassium acetate.	Anti-icing 20g/m2 de-icing 40g/m2	7,6 O. /FT.2 15,2 O/FT.2
BP Chemicals, England	Clearway 2S	Solid de-icer based on sodium acetate for use on thick ice and around stand areas. Is most effective when prewetted with Clearway 1	Anti-icing 20g/m2 De-icing 40g/m2. Best when prewetted with Clearway 1 (5-25%)	7,6 O. /FT.2 15,2 O/FT.2
Hoechst AG, Germany	Safeway SD	Solid de-icer based on sodium acetate	Anti-icing 20g/m2 De-icing 40g/m2. Best when prewetted with Safeway KA (5-25%)	7,6 O. /FT.2 15,2 O/FT.2
Hoechst AG, Germany	Safeway KA	Liquid de-icer based on potassium acetate.	Anti-icing 20g/m2 de-icing 40g/m2	7,6 O. /FT.2 15,2 O/FT.2
Norsk Hydro A/S, Norway	Aviform L50	Liquid de-icer based on potassium acetate	Anti-icing 20g/m2 de-icing 40g/m2	7,6 O. /FT.2 15,2 O/FT.2

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epoke®

Airport spreading areas

- 1) Runways
- 2) Taxiways
- 3) Aprons
- 4) Other outdoor areas

389

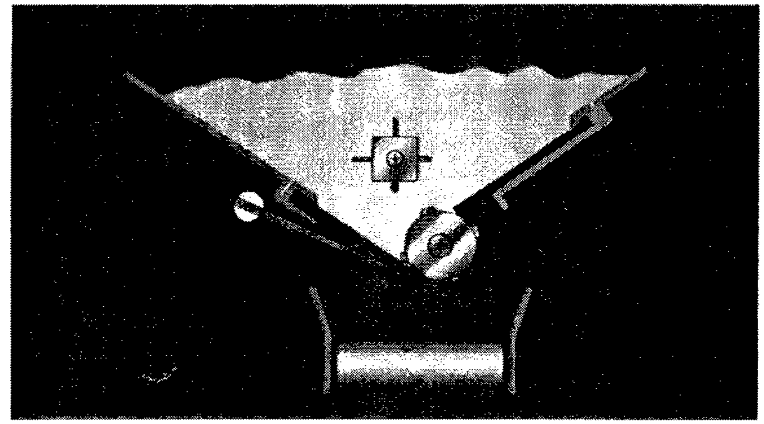
epoke®

Epoke material distribution

- <u>Spreading of dry matter:</u>
  The Epoke principle (impellor, delivery roller, spring base and unloaded conveyor belt)

- <u>Spreading of prewetted material:</u>
  Liquid is added directly to the dry material on the spreading disc.

- <u>Spreading of liquid:</u>
  Fan-shaped spraying via nozzles thus achieving an overlap spraying pattern.
  Delivery at low height from runway surface prevents turbulence and wind problems during spreading.

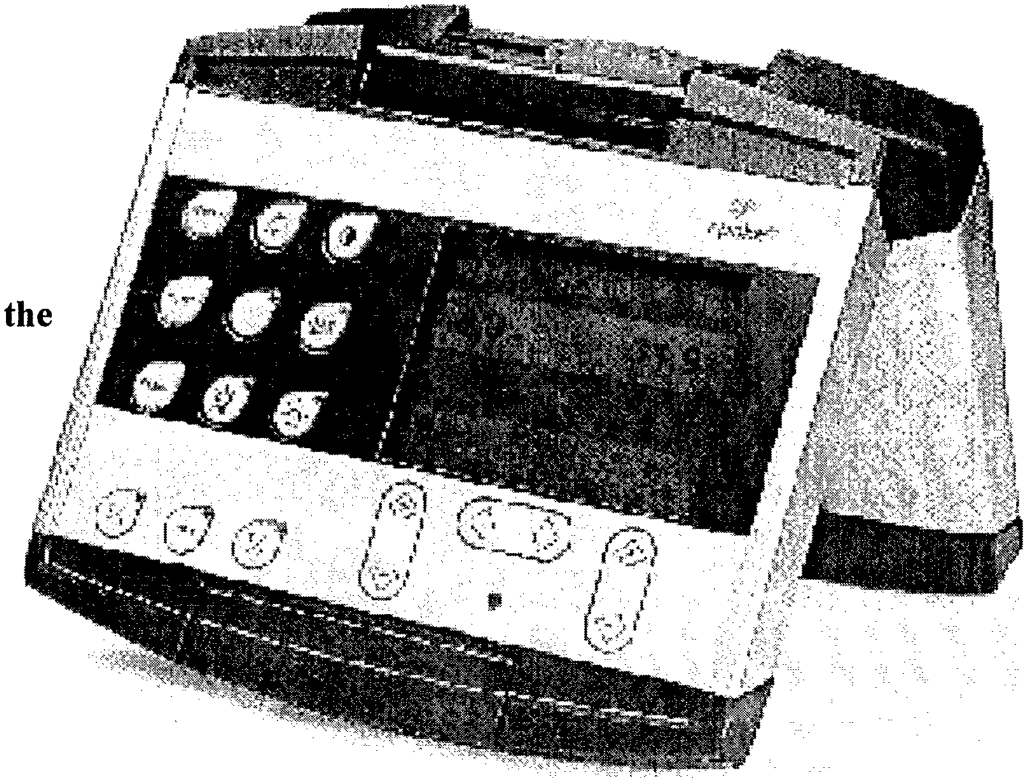


390

epoke®

®EpoMaster controlsystem

- Prepared for data acquisition.
- Spreading quantity per m2., the total, spreading width, date, time and many other data are stored automatically
- All data will be computericed through the EpoVision programme.



epoke®

Ways of spreading

- <u>5 known spreading possibilities :</u>

1) Dry matter
2) Pure liquid
3) Combined dry matter & liquid
4) Dry matter - prewetted
5) Dry matter - prewetted/combined with liquid

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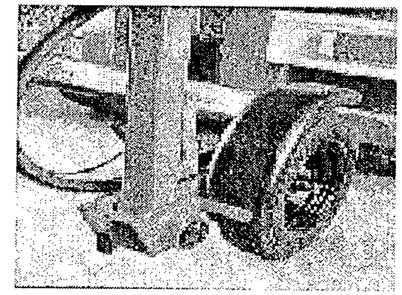
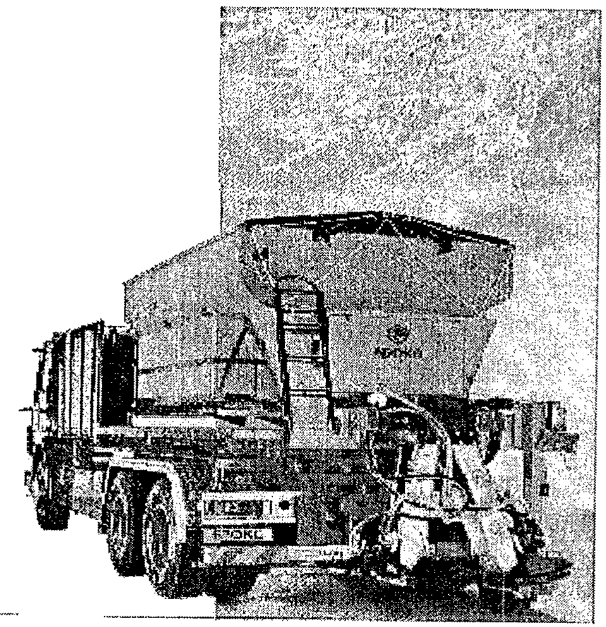
epoke®

Runway spreaders model nos. SW3500 2T og SE3500 2T





Both models are:

- Road speed related
- Both are available with 4 - 12 cu. yards (3 - 9 m3) hoppers for dry material and liquid tanks as desired
- Prepared for data acquisition by means of the EpoMaster control system
- SW-3500 2T
  - Operated by a hydraulic pump on the "5th wheel"
  - Spreading width Sand : 13 - 52 Ft. (4 - 16 meters)
    De-icers : 13 - 40 FT (4 - 12 meters)
- SE-3500 2T
  - Operated by a seperate diesel engine
  - Spreading width Sand : 13 - 79 Ft. (4 - 24 meters)
    De-icers: 13 - 73 Ft. (4 - 22 meters)

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epoke®

Runway Combi model SH4500 2T

- <u>Spreading width</u>

  Dry material........33 - 50 - 57,5 Ft. (10-15-17,5 m.)

  Liquid... ....33 - 50 - 57,5 Ft. (10-15-17,5 m.)

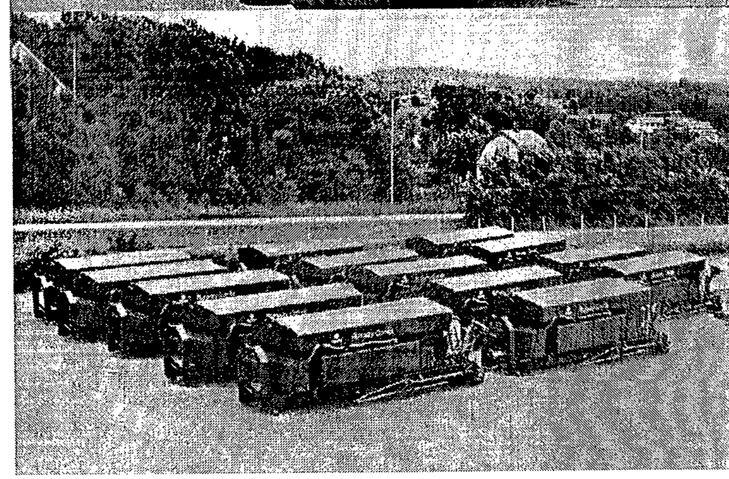
- Working width.....30,5 Ft. (9,30 m.)

- <u>Capacity</u>

  - Dry material: 7,2 Sq. Yards (5,5 m3)
  - Liquid. 997 Gallons (3700 liters)

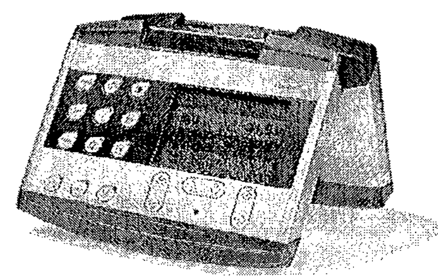
- Road speed related

- Prepared for data acquisition.



EpoMaster

remote control unit



394

epoke®

Runway Combi model SE4500 2T

- <u>Spreading width</u>

  Dry material........33 - 50 - 57,5 Ft. (10-15-17,5 m.)

  Liquid... ....33 - 50 - 57,5 Ft. (10-15-17,5 m.)

- Working width.....30,5 Ft. (9,30 m.)

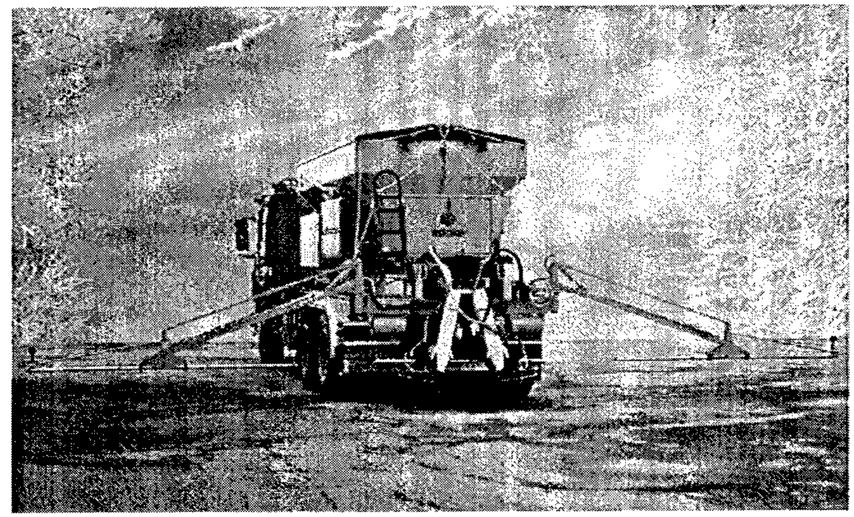
- <u>Capacity</u>

  - Dry material: 7,2 Sq. Yards (5,5 m3)
  - Liquid. 832 Gallons (3150 liters)

- Operated by a seperate diesel engine.

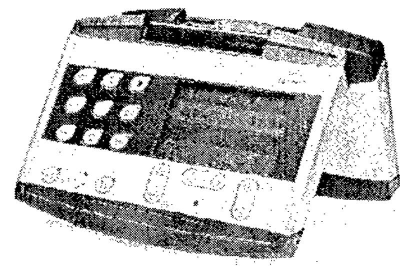
- Road speed related

- Prepared for data acquisition.



EpoMaster

remote control unit

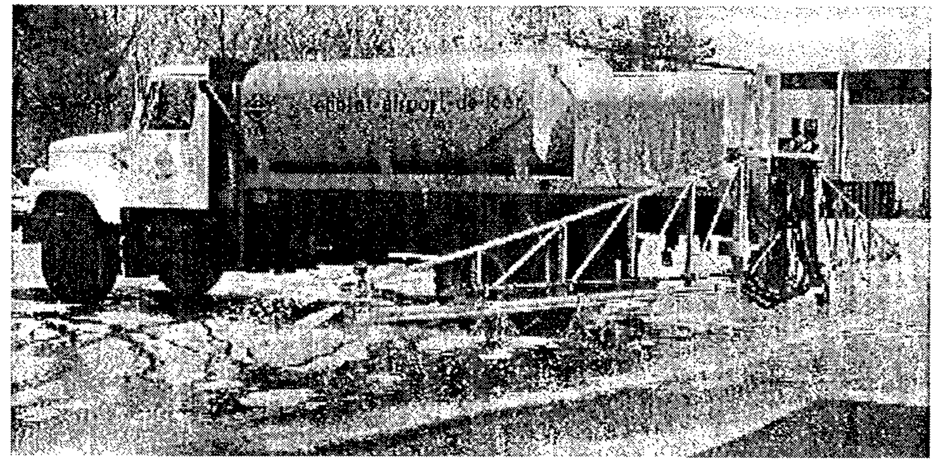


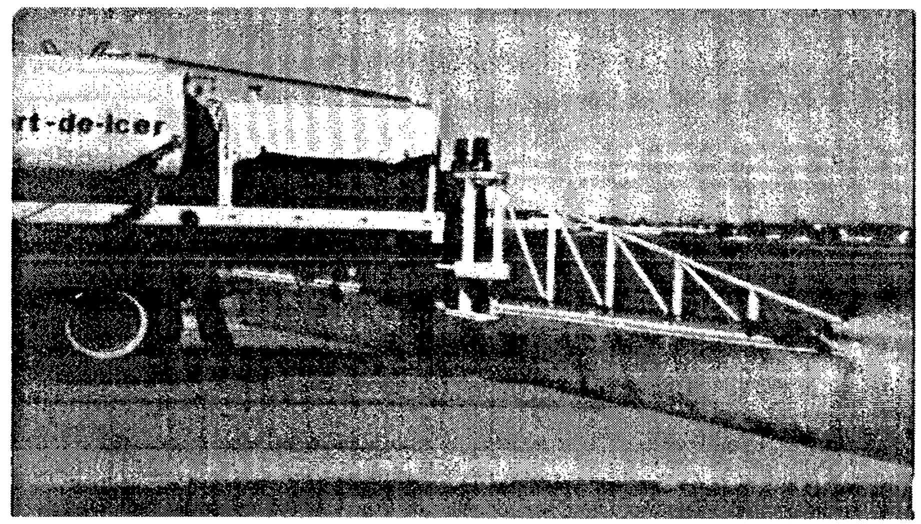
395

epoke®

EpoJet PWV 87 HKD
runway liquid spreader

- Spreading width till 98,4 Ft. (30 meters)
- Working width 65,5 Ft. (20 meters)
- Truck mounted liquid spreader with seperate liquid tank.
- Capacity 2113 or 2641 gallons liquid (8000 or 10000 liter)
- Operated by a (DIN) 27 HP. dieselengine
- Road speed related

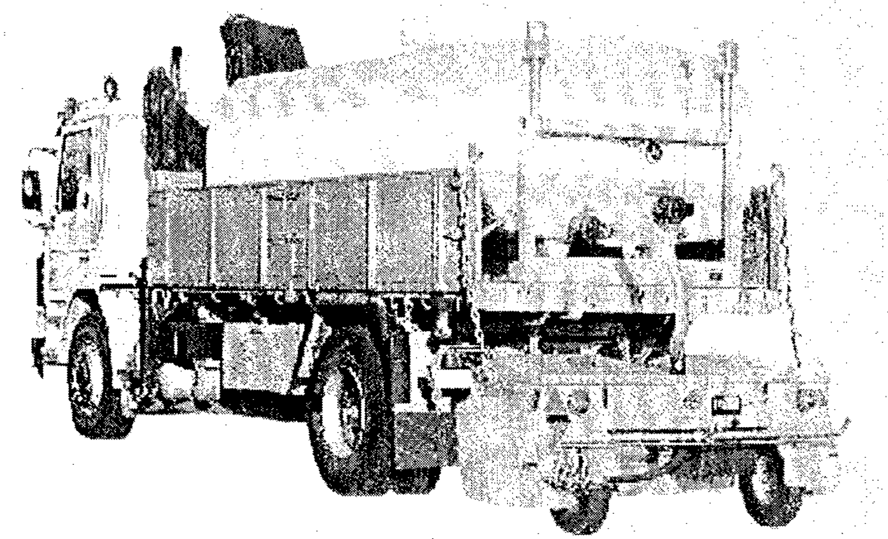




epoke®

Liquid spreader model SW 2000

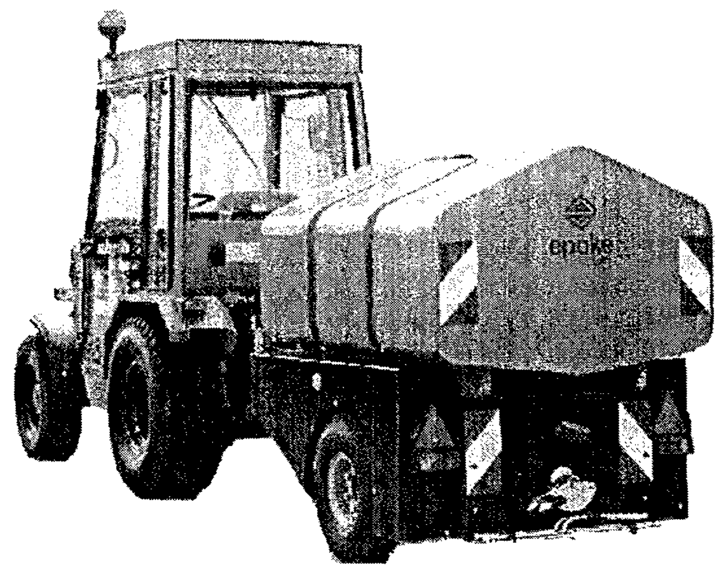
- Spreading width: ......11,5 to 23 FT. (3,5 / 7 meter)
- To be mounted to existing liquid tank
- Spreading quantity.....10 - 60 ccm/FT2. (2,5 - 15 g/m2
- Operated by a hydraulic pump powered by the wheels
- Road speed related



epoke®

"CITY SPRAYER"
Liquid spreader for narrow areas

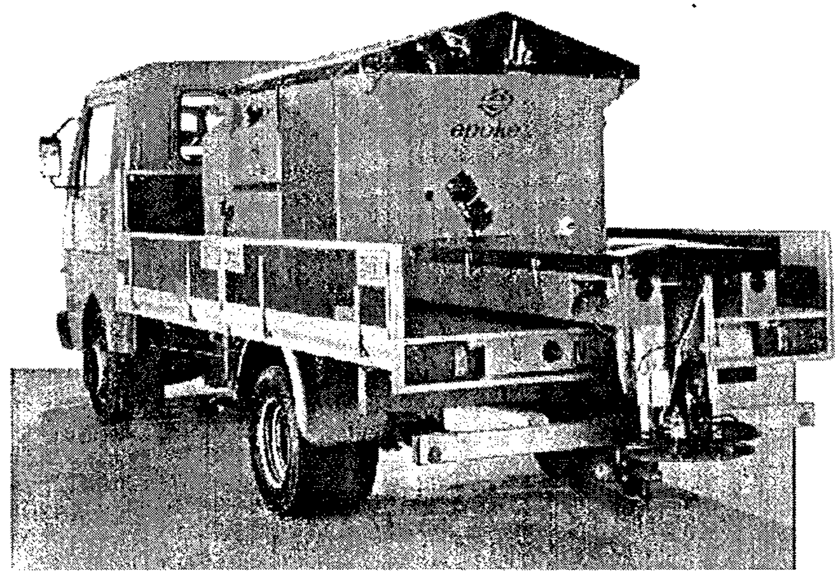
- Spreading width from 3,2 to 7,8 Ft.(1 - 2,4 meters) (with side nozzles in operation)
- Capacity: 264 or 396 gallon hopper (1000 or 1500 liter)
- Road speed related
- Suitable for small tractors like Holder, Izeki etc..



epoke®

“Pick-up Compact “

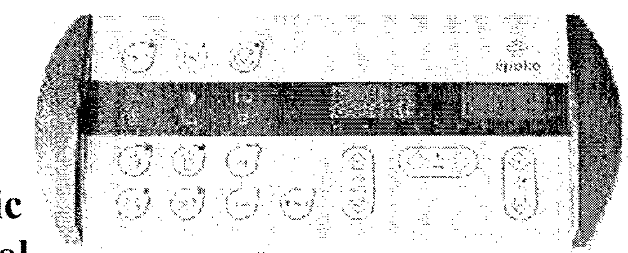
- Including prewetting feature
- Spreading width: 5 to 33 FT. (1,5 - 10 meter)
- Capacity: 1,0 to 1,8 square yards (0,8 - 1,4 m3)
- The spreader can be supplied for operation by a seperate petrol engine or as a hydraulic version for operation by the hydraulic system of the truck



- Spreading quantity

  salt: 2 - 16 ounces/sq.Ft. (5 - 40 g/m2)

  sand: 13 - 66 ounces/sq.Ft. (35 - 175 g/m2)



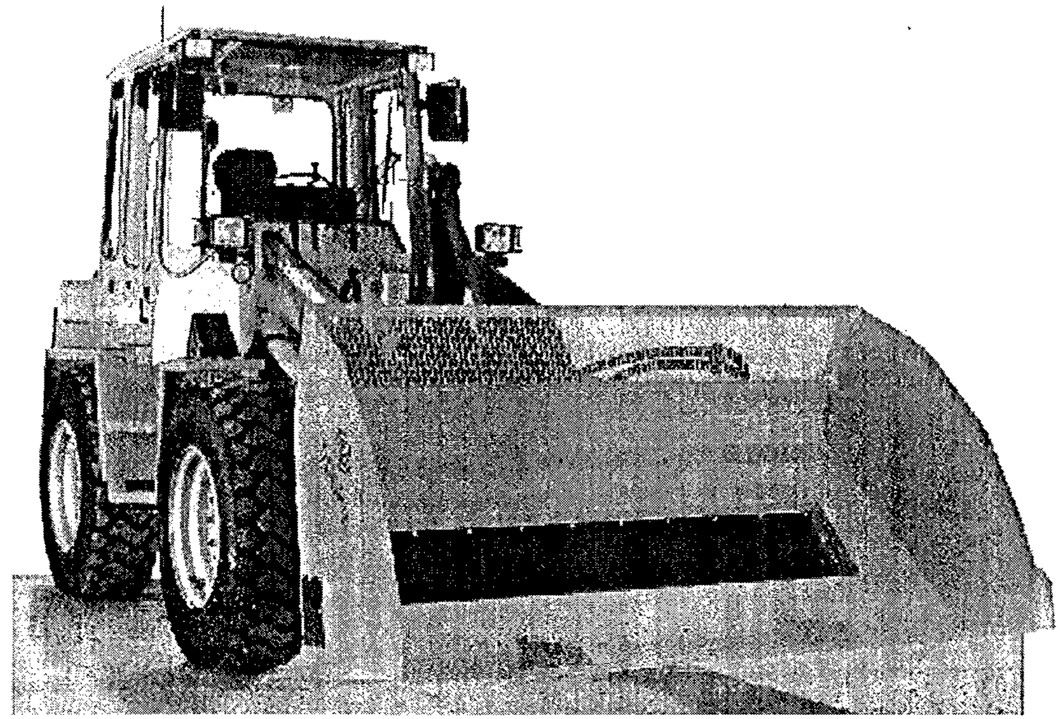
with EpoBasic remote control

- Road speed related

epoke®

Model LM 20
for wheel loaders

- Spreading width min.: 6,5 Ft. (2,0 meter)
- Hopper capacity: 2,9 cu. yards (2,2 m3)
- Mountable and demountable in a few minutes.
- Powered by the hydraulics of the wheel loader
- Spreader, snowplough and loader combined in one

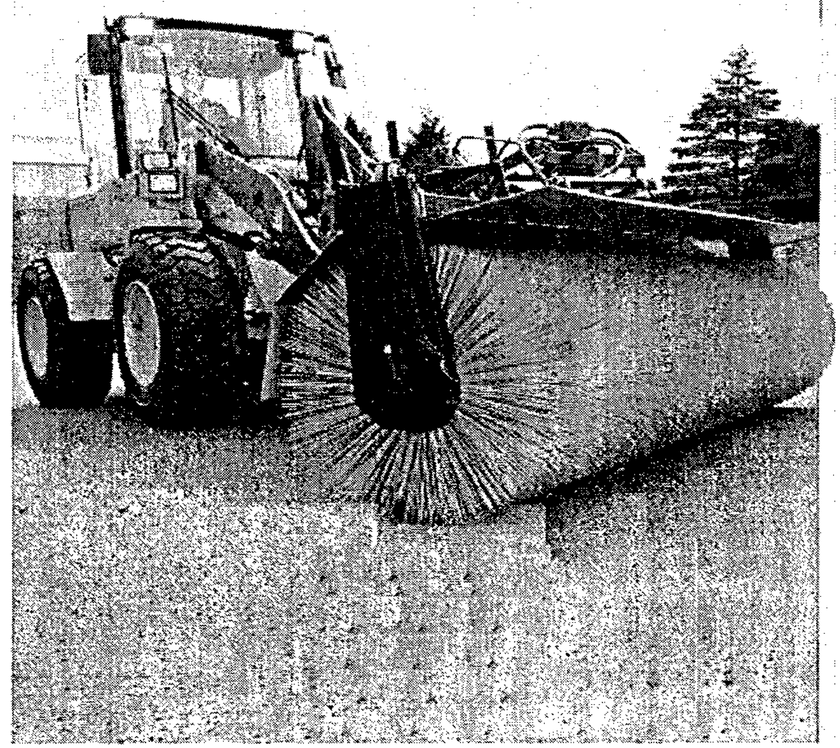


400

epoke®

Sweeper model B35

- Strong sweeper with large sweeping width
- 8,2 - 9,8 - 11,5 Ft. brushes available. (2,5 - 3,0 and 3,5 m)
- 6,5 - 8,2 - 9,8 Ft. sweeping width at 30 gr. angling (2,0 - 2,5 and 3,0 m
- Mountable on mounting tool of the wheel loader or on trucks
- Operated by the hydraulics of the wheel loader
- Constant and reqular pressure with unique balancing

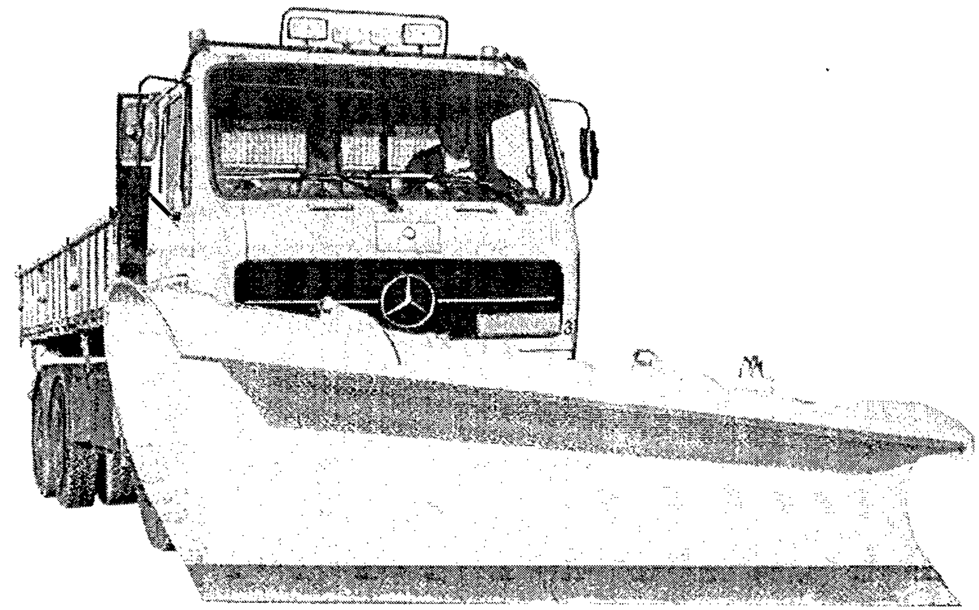


401

epoke

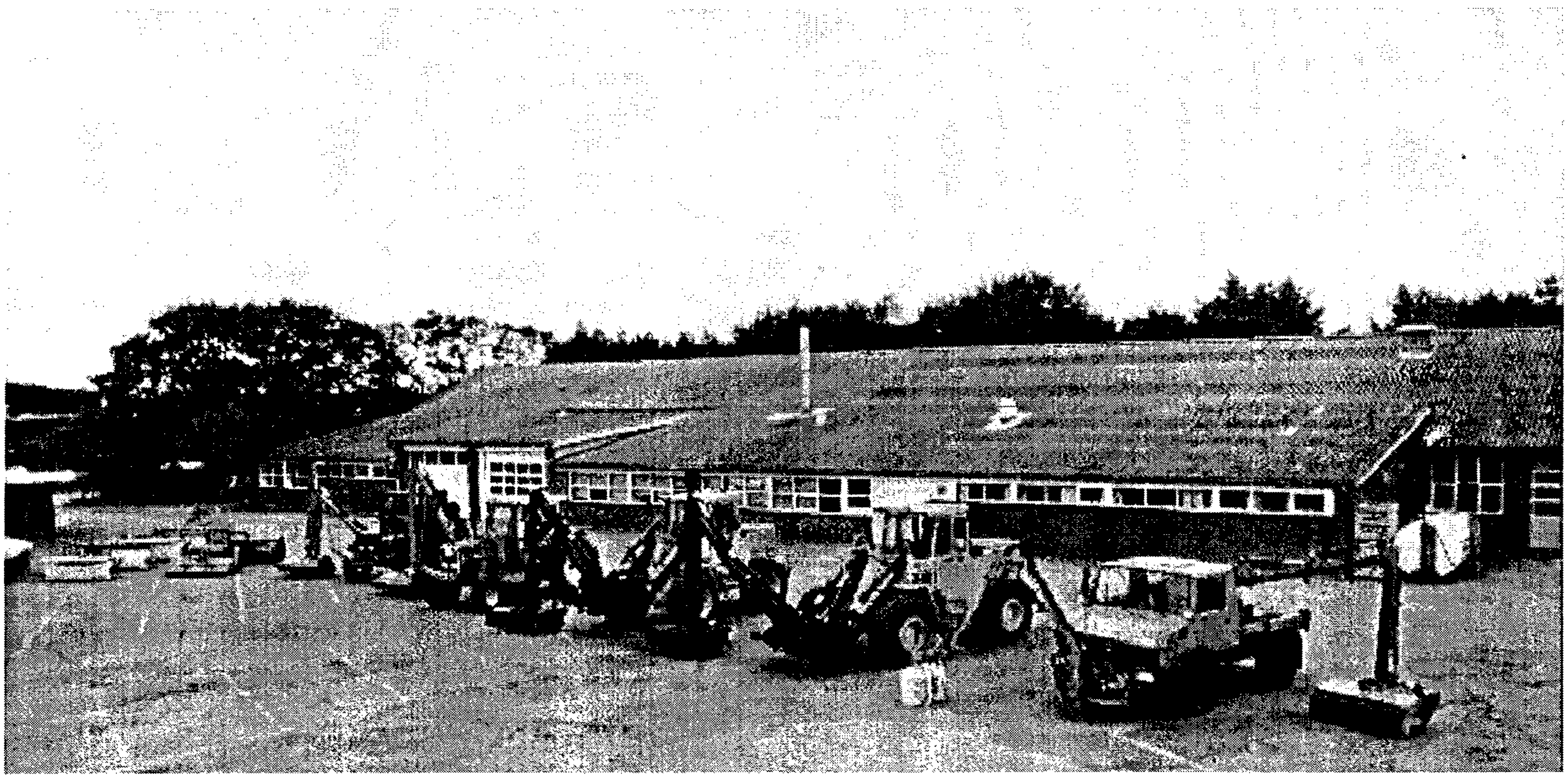
Epoke snowplows

- 6 models
- Clearing width: till 8,8 Ft. (3 m.)
- Mainly for plouwing on low priority areas.



epoke

Epoke grass mowers for different vehicles



- Many different variants:
- For trucks, tractors, wheel loaders etc.

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epoke®

Epoke`s guarantee for quality

- The surface treatment of Epoke consists of:
  - steel ball blowing
  - zinkprimer
  - 2-component primer
  - 2-component paint

- Epoke became ISO 9001 certified in 1993

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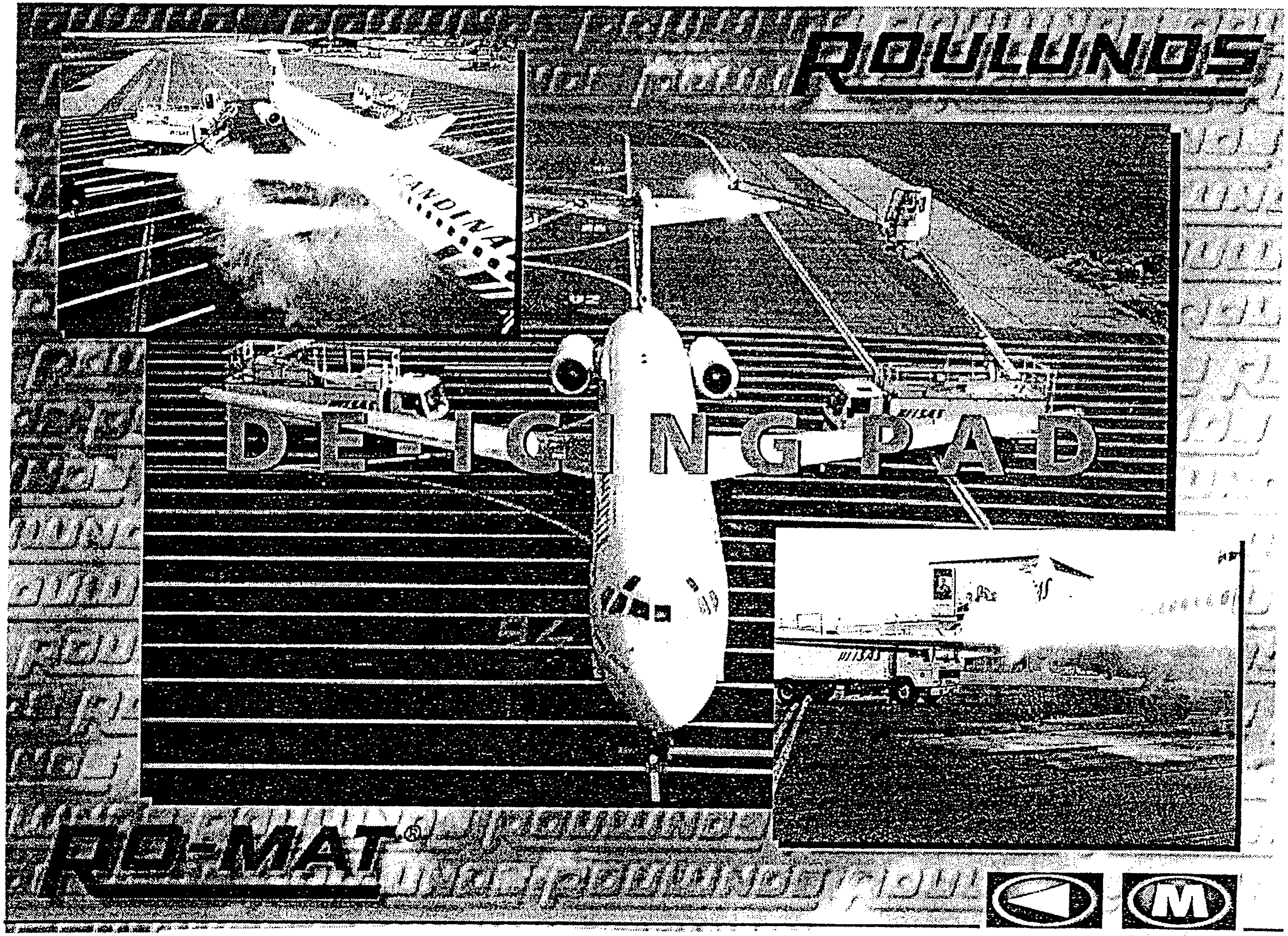

RO-MAT FLUID CONTAINMENT PAD INSTALLATION AT
COPENHAGEN INTERNATIONAL AIRPORT

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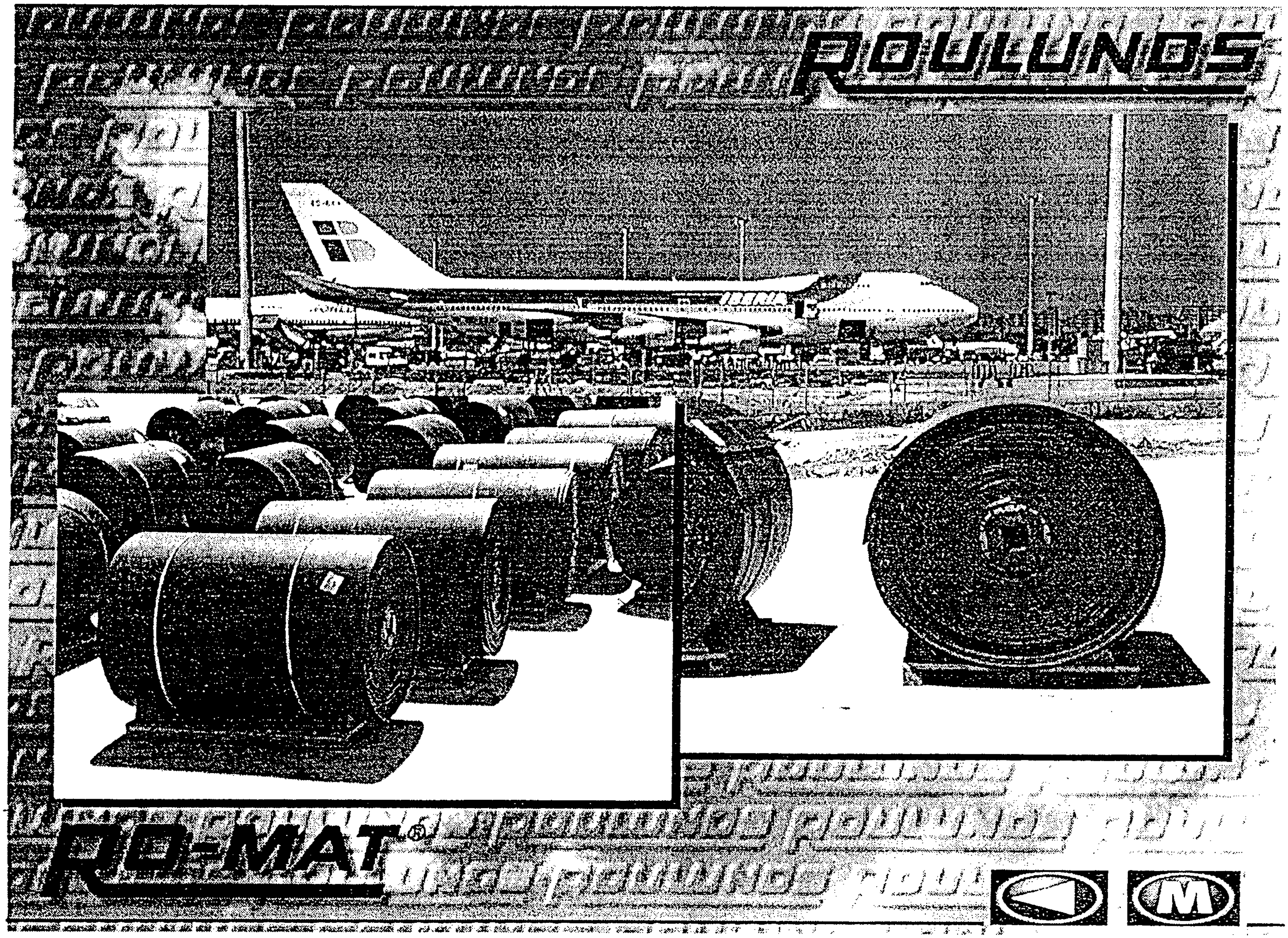
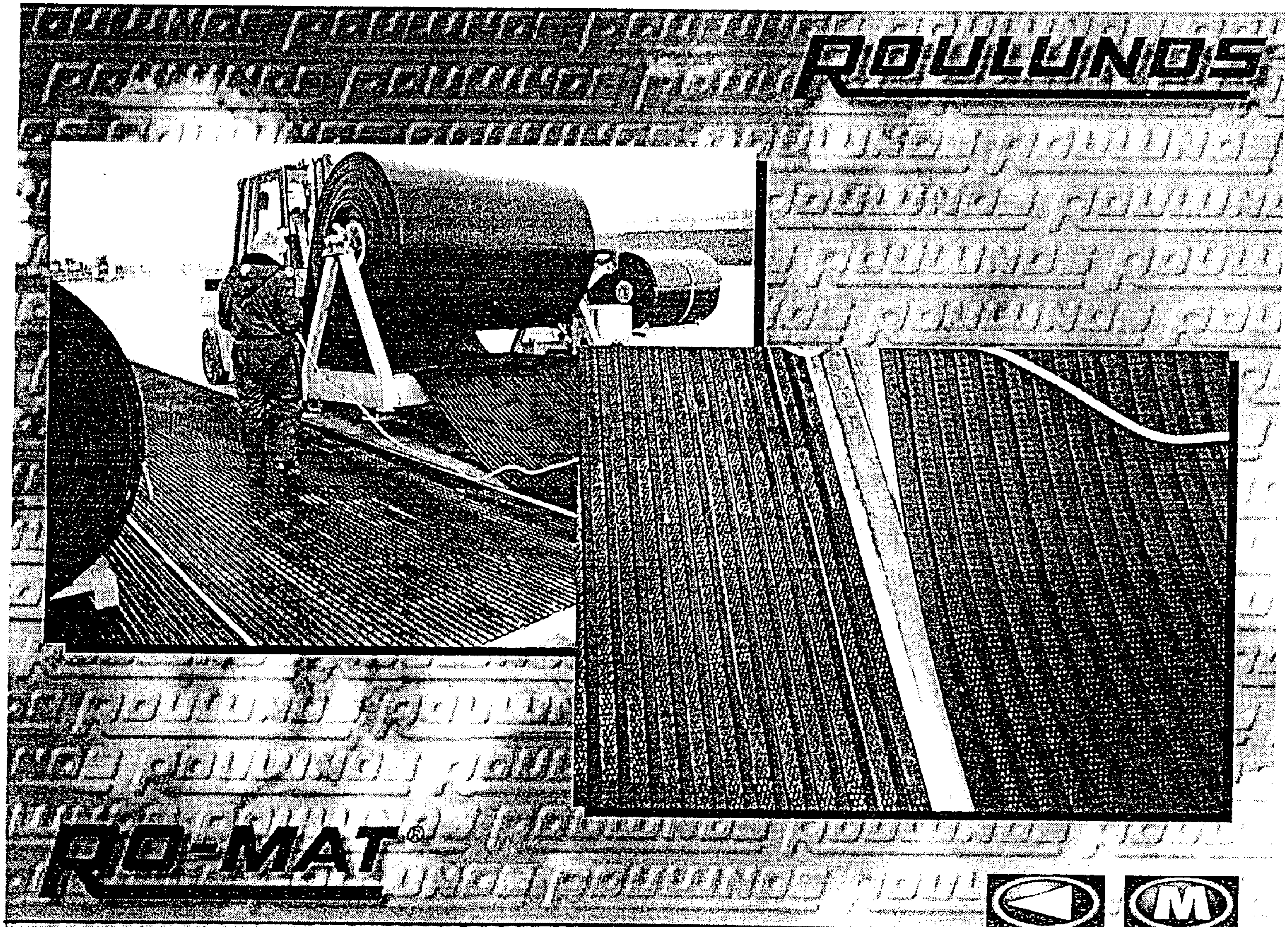
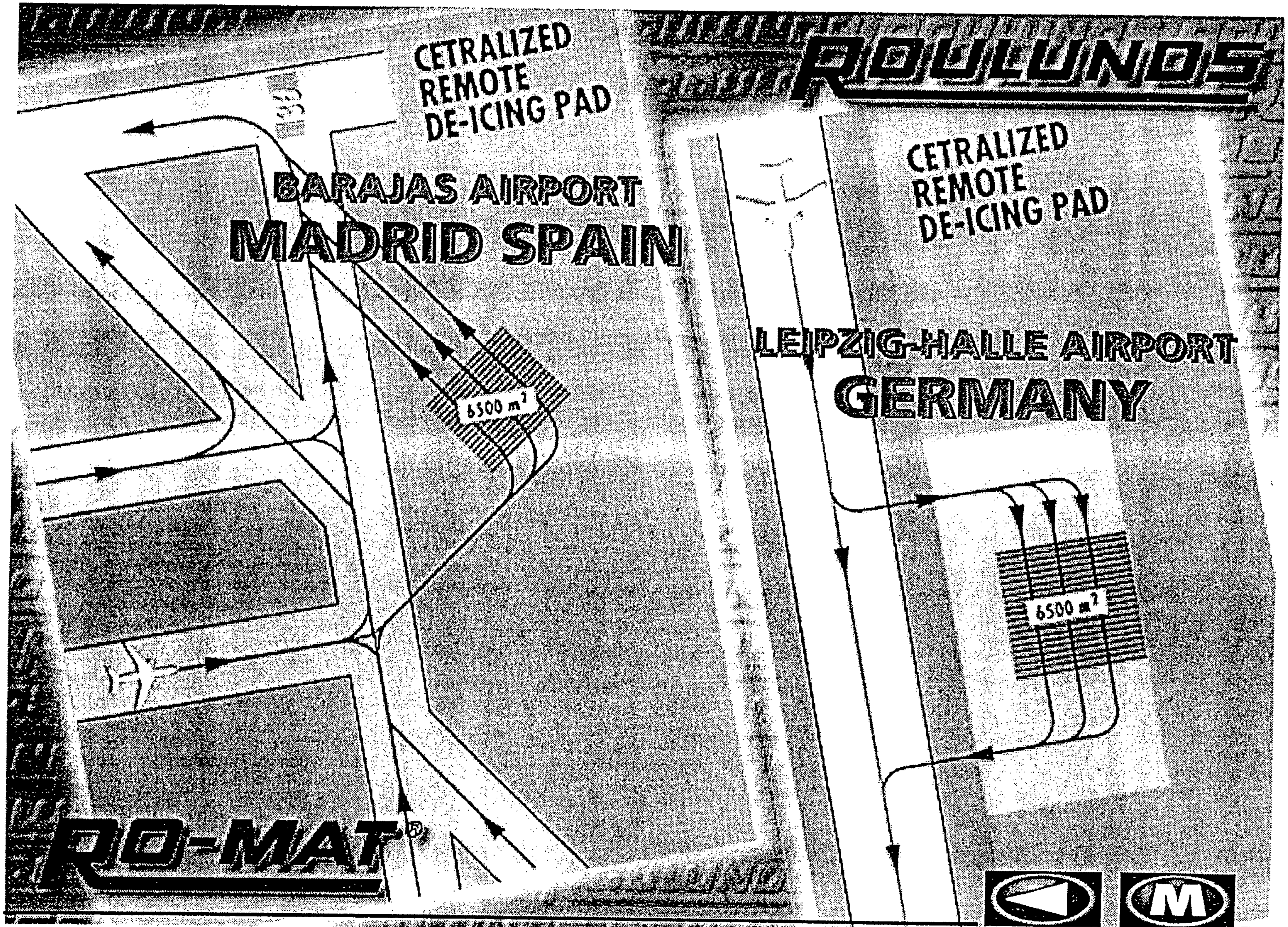


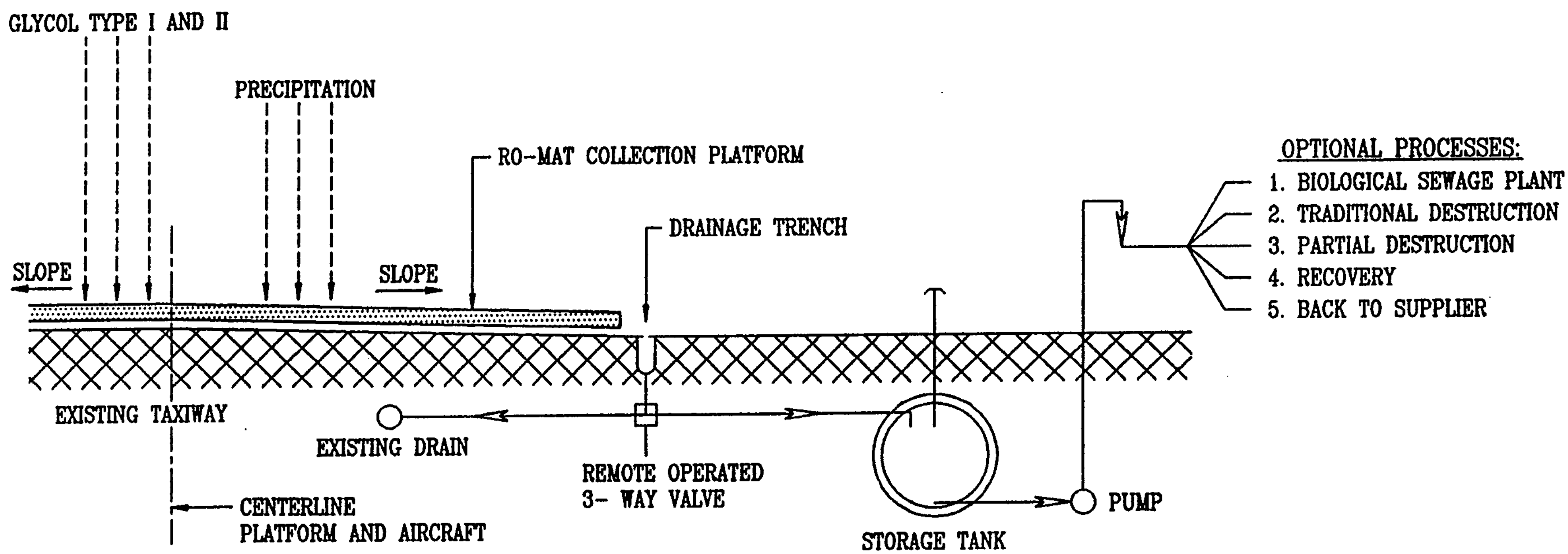
INSTALLATION UNDERWAY AT MADRID INTERNATIONAL AIRPORT, SPAIN



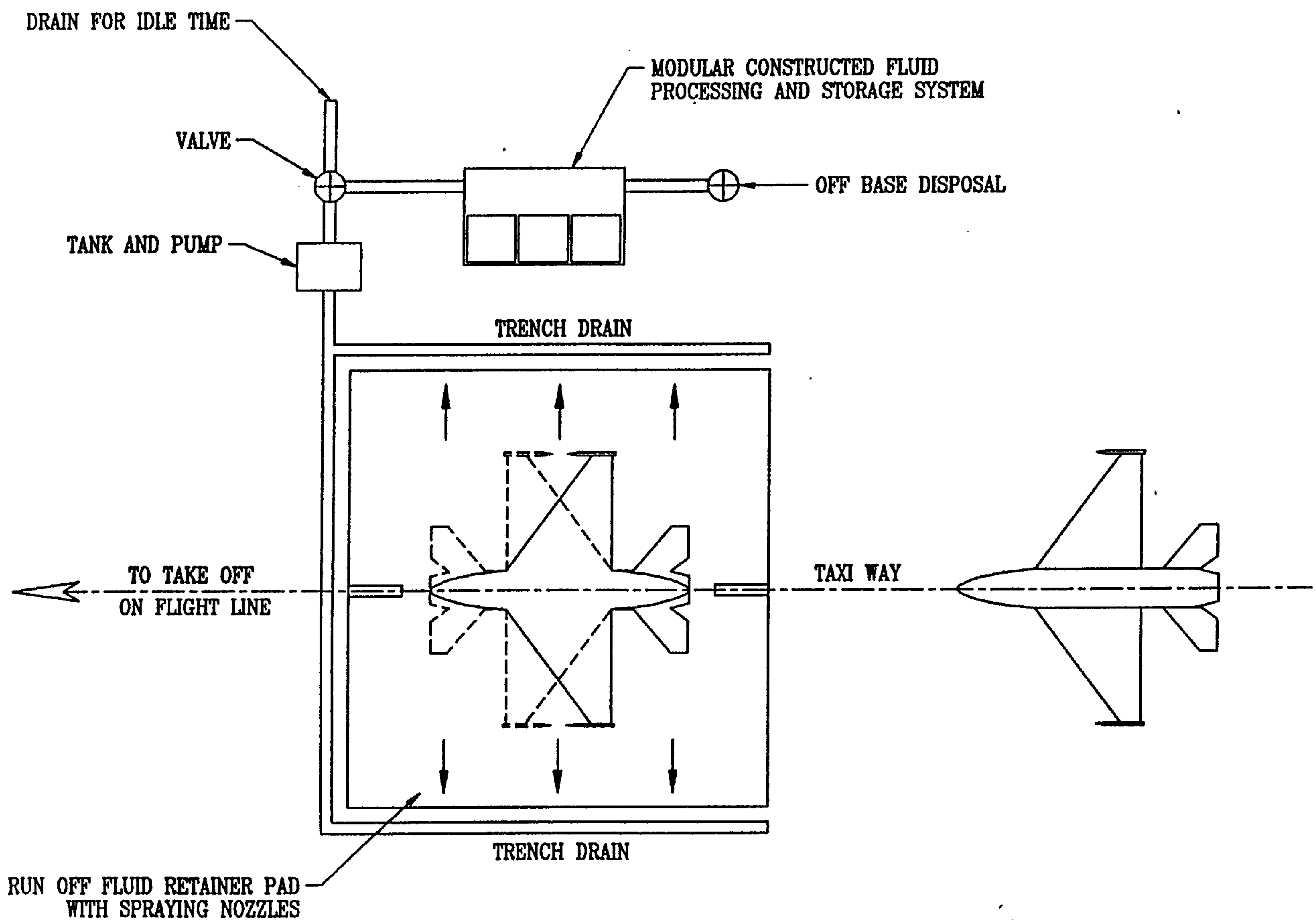
INSTALLATION OF RO-MAT FLUID CONTAINMENT PAD



LAYOUT OF RO-MAT DEICING PLATFORM AT
MADRID, SPAIN AND LEIPZIG, GERMANY



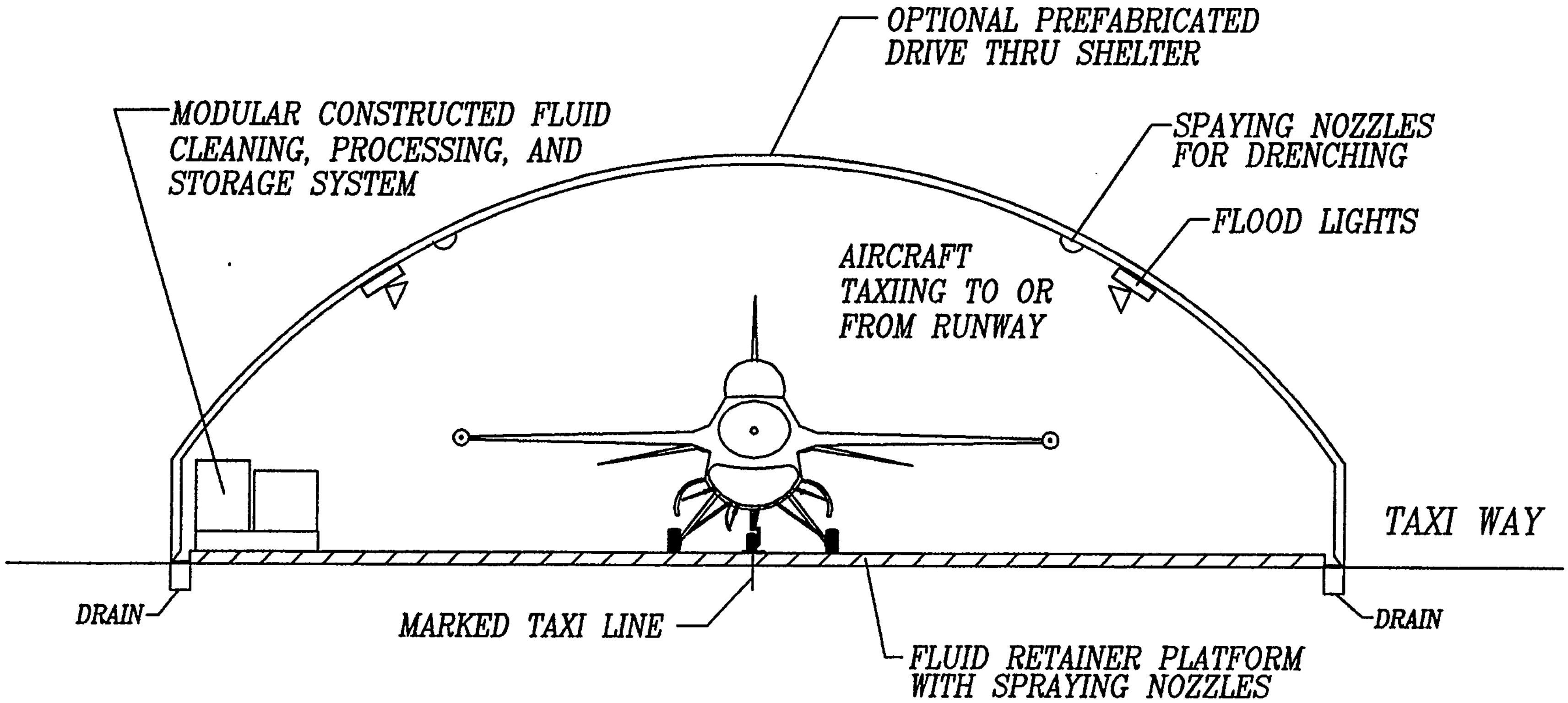
REMOTE DE-ICING PLATFORM SYSTEM



AIRCRAFT DE-ICING/WASHDOWN PLATFORM

PLAN VIEW

SKETCH VI



AIRCRAFT/WASHDOWN PLATFORM

ELEVATION

INTERNATIONAL
AUTOMATED SYSTEMS, INC.
ST. PAUL, MN USA

DEICING TECHNOLOGY CROSSFEED AUG. 20 & 21, 1996 PRESENTATION BY INTERNATIONAL AUTOMATED SYSTEMS, INC. (IAS)

INTRODUCTION:

INTERNATIONAL AUTOMATED SYSTEMS, INC.'S (IAS) PARTICIPATION AS A SYSTEM SUPPLIER, FOCUSED ON GROUND SUPPORT OF MILITARY AIRCRAFT

1. IAS - ITS BUSINESS RELATIONSHIP WITH THE DOD. DEVELOP, DESIGN, SUPPLY, AND INSTALL TURNKEY GROUND SUPPORT SYSTEMS UNIQUE TO MILITARY AIRCRAFT.

1.1 What is our role in deicing of military aircraft.

1.2 Specific to IAS' presentation at this conference:
Solutions to storm water runoff problems - The Fluid Capturing System

2. APPROACH TO DEVELOPMENT OF A DEICING SYSTEM UNIQUELY SUITED FOR MILITARY APPLICATIONS.

Based on IAS' survey of military bases, the design must have the following features:

2.1 Modular and unitized design to allow system modules to meet varying sites' restraints and applications without major redesign.

2.2 Design for flexibility in application and capability of redeployment with short notice to respond to mission changes.

2.3 Adaptable for change from deicing system to clean water wash down and scrub down cleaning for year-round utilization of the system.

2.4 Environmental compliance with the Clean Water Act and with federal, state, and local regulations.

2.5 Only performance-tested system modules are used.

2.6 Simplicity in installation and maintenance.

2.7 Suitable for remote location at the runway.

2.8 Cost-effective design.

3. THE PRINCIPAL SUBSYSTEM - <u>FLUID CAPTURING SYSTEM (THE PAD)</u>.

Principal design features:

3.1 Completely waterproof without seepage to ground.

3.2 High fluid retainage and controlled runoff capability of surplus fluid even in high winds and when engines are running.

3.3 A close circuit fluid containment, drainage, and collection system.

3.4 Easily redeployable without need for replacement of parts.

3.5 Same basic product adaptable for deicing pads for fighter, tanker, and transport aircraft.

3.6 High vehicle braking characteristics without producing a "carpet-effect" when aircraft or spraying trucks are braking.

3.7 Adaptable for mobile spraying, fixed, or automated spraying system.

3.8 Able to withstand other chemicals associated with aircraft operation.

3.9 Simple installation without need for foundation work beyond the drain system and collection tank.

3.10 The pad must be adaptable for watertight installation of spraying nozzles and taxiing lights in the pad.

3.11 Conventional snow clearing equipment must be usable for the pad.

3.12 Low maintenance cost.

3.13 Long service life (15-20 years).

3.14 Low initial investment cost. Less than a comparative concrete pad.

4. THE FLUID COLLECTION PRODUCT - THE RO-MAT.

4.1 IAS has a product that meets the above stated specifications. It is the RO-MAT manufactured by Roulunds Fabriker, Denmark.

-RO-MAT fluid capturing platforms have been installed on major commercial airports in Europe and are used in deicing of commercial passenger aircraft

-IAS is the agent for sales of RO-MAT systems to the DOD.

-The RO-MAT product will now be introduced by Mr. Lars Kock, Product Manager, Airport Ground Equipment, A/S Roulunds Fabriker.

PRODUCT DESCRIPTION

The central component of an environmentally acceptable aircraft deicing or wash down system is the runoff fluid containment platform—**the RO-MAT**.

The RO-MAT is a unique product manufactured by Roulunds Fabriker A/S in Denmark. Roulunds is a 250 year old, diversified international corporation serving a broad spectrum of industries around the world. The company is a leader in several rubber related environmental tools such as in the field of ocean oil spill containment technology and equipment.

The RO-MAT platform has been installed and is in successful operation on commercial airports as the critical item in ecologically acceptable deicing collection and processing systems. These installations have proven that much more fluid can be collected by using the RO-MAT instead of concrete or asphalt pads.

The RO-MAT presents the only fail-safe, close circuit, runoff fluid containment and collection system available and in commercial use today anywhere in the world. RO-MAT containment systems for glycol deicing systems are in use in Europe on large international airports; such as Madrid, Spain; Leipzig, Germany; and Copenhagen, Denmark.

The RO-MAT platform is a deeply ribbed, steel belted, tough rubber matting of virtually indestructible quality that limits the runoff fluid to the mat and the connected drainage system. From there the fluid is channeled into holding tanks for cleaning, processing, storage, and fluid recycling or shipping.

The RO-MAT platform (patent pending) uses the normal slope of the taxiway, which is about 1.5 percent from the center line in both directions, to drain deicer fluid along a series of transverse grooves in its surface and through a drainage system at the bottom of the slope into collection tanks. Since the RO-MAT platform is installed as a large mat, it is easily disassembled and redeployed in case of mission changes.

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The principal feature of the RO-MAT is that it provides a performance tested, fluid-capturing platform that meets the current stringent ecological and safety codes:

1. **Construction.** The RO-MAT is molded EPDM (ethylene-propylene elastomers) that offers superior ozone and weather resistance, excellent heat resistance, low compression set, and low temperature flexibility. EPDM has excellent resistance characteristics against abrasion, chemicals, and ultraviolet light. The mat is 3/4" thick and has a rugged surface to prevent skidding and steel reinforcement cables to prevent braking from producing a "carpet-effect" of the mat. The mat is rugged enough to allow the use of conventional snow removal with nylon brush equipment to clean the mat.

2. **Aircraft and vehicle ability to safely stop on the platform.** One of the stringent requirements for authorized use of any fluid collection platform on a commercial airport is the ability of aircraft and heavy service vehicles to safely stop when brakes are applied. The runoff fluid in a deicing operation consists of glycol, snow, crushed ices, oil, and dirt which renders most smooth surfaces extremely slippery and unsafe for vehicle and people traffic. The configuration and selection of the material of the RO-MAT provides a safe and reliable braking surface. Extensive testing in Europe has established the criteria for safe braking characteristics for aircraft and vehicles. The RO-MAT meets the requirements which have cleared the product for application on commercial airports with traffic of large passenger and cargo aircraft. The RO-MAT can be furnished with yellow taxi lines and in the pad, imbedded watertight light fixtures, as required for navigational assistance, and stainless steel spray nozzles for under wing and landing gear deicing.

3. **Fluid collection and runoff.** The configuration of the mat surface allows the runoff fluid to be retained on the mat for runoff even when exposed to wind and air current from the aircraft's jet engines at idle or breakaway power. On commercial airports, the aircraft moves over the platform on its own power. A copy of a performance report for the RO-MAT system issued by Scandinavian Airline Systems, dated 6 August 1993, is copied on page 1-4. This report states that 75% of the sprayed glycol was collected on the platform during the winter of 1992-93. The remaining 25% attached to the aircraft blows off during taxiing and takeoff.

414a

The RO-MAT is designed to provide collection and convenient drainage of fluid runoff into storage tanks for processing and/or disposal. The drainage system is a custom-designed in-ground system consisting of standard components fitted to the application.

4. **Installation.** Due to the design of the RO-MAT platform, it is well suited for the location of the deicing process at close vicinity to the takeoff point on the runway. The platform can be installed on any concrete or asphalt apron or taxiway surface quickly and without expensive time-consuming surface preparation. The mat will follow the sloped contour of the taxiway, which will facilitate the waste fluid runoff and drainage. Only minor modifications to existing aprons or taxiways are required for installation of the trench drainage system that serves the RO-MAT platform. The RO-MAT is manufactured and shipped in 7 ft wide rolls which are mechanically connected by stainless steel hardware.

5. **Maintenance.** Once the RO-MAT is installed, it is virtually maintenance free. The mat is almost indestructible, and the anchoring hardware components are all fabricated of stainless steel. Only the edges of the platform are anchored to the ground. Each of the 7 ft wide ribbons of mat are connected to each other with stainless steel screws acting as expansion joints.

SAS

Kastrup, 6th August 1993
CPHTS-B/Jens Andersen

REPORT CONCERNING COLLECTION OF DE-ICING FLUID AT CPH IN WINTER 1992-93

In order to protect the environment the Copenhagen Airport Authority installed a de-icing platform (Ro-Mat) before the winter season 1992-93 for collection of the used Glycol.

All used and collected Glycol has been registered by measuring the content of the used Glycol each time we forwarded it to the nearby waste water treatment plant. We found that the Glycol concentration we delivered was between 25,8 and 32,5%.

We had 1822 de-icing operations on the platform. We used 157.000 kg 100% Glycol and collected 120.000 kg 100% Glycol - which means that approx. 75% of the sprayed Glycol was collected on the platform.

The total consumption of Glycol in CPH was:

861.366 kg 40% Type I - and
188.665 kg 50% Type II

corresponding to 439.000 kg 100% Glycol, of which

157.000 kg were used on the platform - and
~ 36.000 kg were used as prevention after landing (3600 operations).

The remaining 246.000 kg were used at the gates.

A.R PLUS
AIRFREEZE SERVICES

Coastal Fluid Technologies, Inc.
102 Magnate St.,
P.O. Box 81577,
Lafayette, LA 70598-1577

Phone : 318-261-0796
Fax Phone: 318-261-0797

Attention : Glenn Vanderlinden - Director, Sales & Business Development

Voicemail : (800) 535-8412 Ext. 364
Pager : (800) 829-6991
Return Fax : (905) 643-2622
Phone : (905) 643-4793 - dial Ext. 364 for voicemail if system prompts
WWW E Mail : glennv@coastalfluid.com

Subject: Coastal Fluid Technologies, Inc. (CFT) has is an integrated service provider in the field of glycol recycling and contaminated stormwater management. It bases these capabilities on their proprietary and patent pending RampRanger collection technology and their Glyvap mobile evaporation process. Both of these technologies have been field proven for over 5 years now.

The collection experience began 5 years ago in airports that were facing severe environmental pressures but had no technical means of solving the problem of spent deicing fluids from migrating into stormwater systems. The RampRanger was developed to remove as much glycol from the spraying area as possible during a storm event but more importantantly, to clean the residue that remained after the deicing event to allow further precipitation to flow compliantly to the storm drain.

It soon became apparent however that while containing the collected fluid, and stripping residual glycol from the surface, prevented stormwater problems, it also created huge financial liability in paying disposal charges. CFT introduced it's recycling capabilities to the industry 18 months ago and has been piloting it with fluids from Chicago, Detroit, Cleveland and Pittsburgh airport throughout last winter. The operation recently began processing 1,000,000 USG of glycol that remained stored there from last years collection operations.

CFT has packaged these technologies and services in a flexible manner to allow custom solutions to specific airport operations. In addition, any recycling revenues that are possible from a project are used to offset collection and management costs. This approach allows proper staffing of projects with experienced people that concentrate on the three main needs of the client, environmental compliance and an affordable cost for the solution.

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Coastal Fluid Technologies, Inc.

Recycling and Treatment Services
for Spent Deicing Fluids
and Contaminated Stormwater

The Problem Defined

- Aviation saftey priorities require deicing fluid to be sprayed as and when required
- Most deicing fluids have extremely high BOD values and some have problem toxicity levels
- Environmental and drinking water regulations require BOD and toxicity to be controlled to specific levels in stormwater
- Most airports were not designed to contain, store or treat the large volumes of stormwater that these substances contaminate

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Solutions Utilized to Date

- Direct discharge permits to POTW with surcharges
- Stormwater retention basin construction
- Remote deicing - central deicing facilities
- Service contracts to meet stormwater permits
- Multi million dollar fixed process facilities to meet maximum flow conditions
- Expensive trucking solutions to conventional liquid waste disposal facilities

Results Realized to Date

- Large POTW surcharge bills and spring odor problems due to limitations on discharge rates
- Multi million dollar infrastructure programs to build deicing facilities that may not succeed in improving stormwater quality
- Service and trucking contracts at a cost of hundreds of thousands of dollars per year
- Expensive treatment facilities that do not meet the loading of the sites they were designed for

Ideal Solution Required

- A service solution that recycles spent glycol and returns a value sufficient to offset program costs
- A fully portable solution that can be mobilized "on site" and adjusted to meet seasonal volume needs
- A flexible purchasing package that can add ramp services for low additional fees - as required - with costs that are based loaded by equipment used in the recycling operation
- Proven experience and a 'pay for performance' business arrangement that protects the customer

The CFT - AR Plus Program

- CFT will provide collection and process services relating to the glycol recycle operation - No Charge
- CFT may at their option, intercept the resulting contaminated stormwater on a project on a right of first refusal basis - at a charge of 75% of the lowest site treatment alternative - POTW or offsite discharge
- CFT may at their option, treat the remaining fluid held in airport retention ponds prior to discharge to POTW or storm - 75% of POTW or offsite alternatives
- Additional ramp services - unit priced with minimums

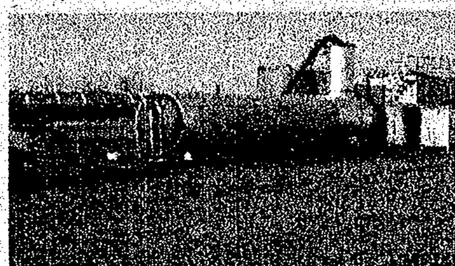
Step 1 - RampRanger Collection

- 1,200 USG capacity
- ramp sanitizing to non detectable glycol limits
- operates in heavy weather & temperatures of < 20 degrees F
- improves surface friction & collects FOD

Step 2 - On Site Storage

- CFT will provide 20,000 USG portable tanks
- CFT can provide 100K USG to 750K USG temporary tanks
- airport needs to provide permanent tanks
- airport needs to provide stormwater retention basins

Step 3 - On Site Processing



- All recycled product leaves the site non - regulated
- Recycling reduces POTW surcharge by 30% to 60%
- Volume reduction reduces in trucking & waste disposal fees

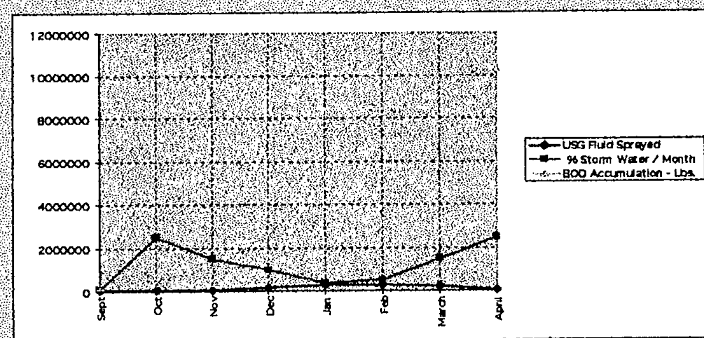
Step 4 - Uses of Recycled Product

- CFT uses PG and EG to produce oil field treating products
- CFT produces Fluidgaurd 50% - 98% EG and PG, high quality automotive coolants
- Surplus inventory is sold to industrial and other glycol users

Step 5 - Primary Stormwater Treatment

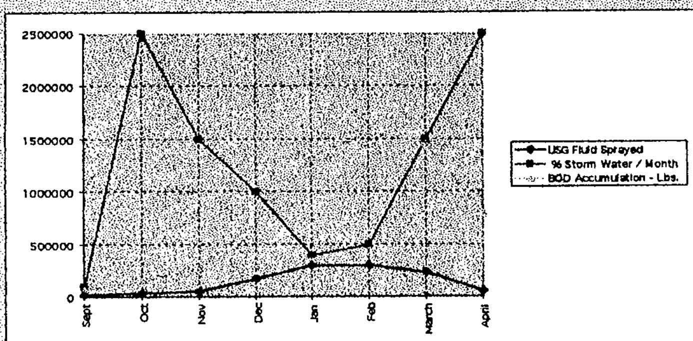
- Cost effective recycling will result in 30% to 70% of fluid sprayed going to water treatment system - POTW or stormwater
- Due to the extremely high BOD value of EG, PG and other deicing chemicals (potassium acetate, sodium formate) this disposal stream costs millions of dollars annually in large airports - normally billed in landing fees to the airlines
- CFT can intercept these streams and treat these volumes, utilizing waste heat and energy from the recycling operation

Normal Stormwater BOD Pattern



BOD accumulates throughout the season to contaminate total storm flow

Recycle Stormwater BOD Pattern



BOD is recovered in peak spraying periods to create spring runoff dilution effect

Net Recycling Benefits to Fluid Sprayers

- Fee reductions from POTW - No charge
- BOD dilution effect to allow larger volumes of retention pond runoff to go POTW faster and at lower surcharge rates - No charge
- Non recycled volumes of BOD are reduced low enough to make Primary Stormwater Interception and Treatment feasible in many cases - 75% of competitive alternative fees on throughput basis
- POTW capacity becomes a free fall back resource

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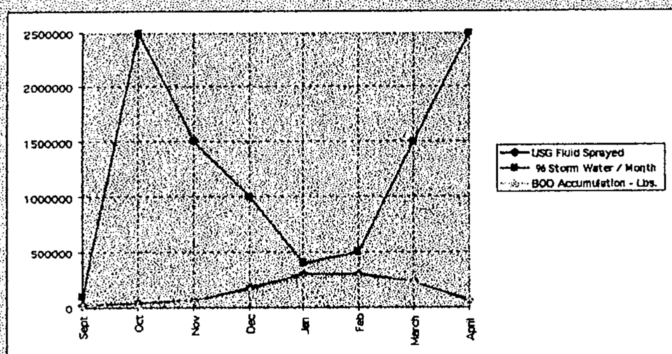
Primary Stormwater Treatment BOD Pattern



BOD discharge to POTW or storm ponds is reduced by 90%

Primary Storm Treatment Method

- Biotreatment system and associated processes are physically located by CFT Glyvap process to utilize waste heat and energy
- Each system is designed to site parameters
- All operation and management is included with reporting to applicable authorities
- All capital and maintenance is included based on a term of operation - normally 5 to 15 years - % savings off competitive disposal increases with term length

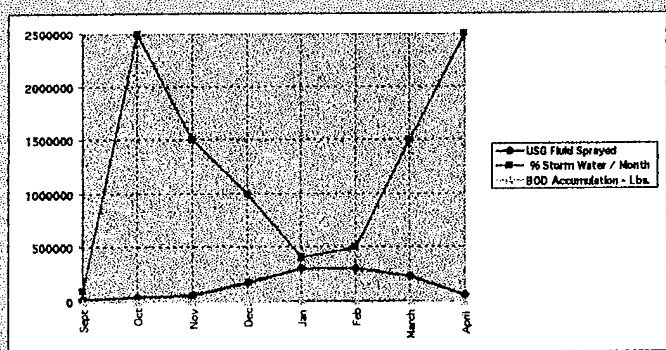
AR Plus Advantages in Primary Treatment

- Control over BOD levels being sent to treatment
- Recovery of energy
- Field experience with glycol degradation under winter conditions
- Strong resources in engineering, equipment & biomass supply

Secondary Stormwater Treatment

- After recycling and primary treatment, stormwater in retention ponds will be very low in glycol / BOD
- Low levels of BOD can be treated effectively and quickly as temperatures rise above 40 degrees F
- In situ treatment of BOD in retention ponds can :
  - improve pond conditions environmentally
  - reduce odor problems as weather warms
  - further reduce POTW costs
  - improve rate of stormwater disposal in the spring

Secondary Stormwater Treatment BOD Pattern



Retention pond discharge levels can be reduced to < 500 PPM BOD

Customer Commitment Required

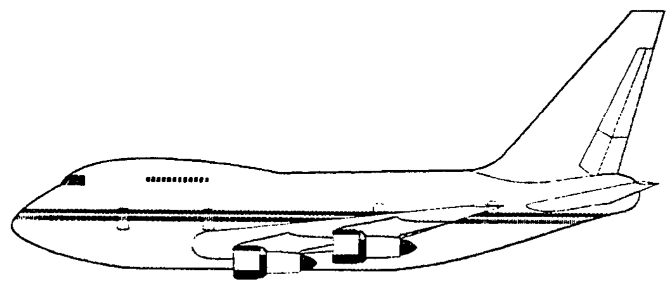
- AR Plus Recycling Services - No Charge
  - AR Plus receives a 3 year minimum operating order to collect glycol as and when they choose
  - AR Plus receives a right of first refusal to treat stormwater that cannot be effectively recycled
    - Primary Treatment - a 5 to 15 year operating order is needed to provide incrementally more attractive savings on treatment throughput costs
    - Secondary Treatment - can be tied to the same operating order period as the recycling contract as major capital expenditures are not required

Other Customer Services Available

- Additional services can be contracted on a P.O. basis as and when required with additional RampRanger operational time :
  - Improve ramp friction for push backs
  - Clean lead in lines
  - Contaminated snow control
  - Pick up FOD
  - Control stormwater run off quality from specific ramp surface areas to permitted levels
  - Other miscellaneous sweeping / scrubbing

Glycol Recovery Vehicles were briefed by Vactor Manufacturing Co. No briefing charts were used but brochures were passed out to those in attendance. Additional information is available from the company.

PRESENTATION
at
De-icing Technology Crossfeed
ANSER
1215 Jefferson Davis Hwy. Suite 800
Arlington, Va. (Crystal City)



for

Anaerobic BioFiltration Glycol ReductionProcess

presented by

BioFiltration Systems™, Inc.

1800 Second St.
Suite 808-13
Sarasota, Florida 34236
(941)953-5200 Fax 953-5353
Toll Free 1-888-Bio-Fltr

21 August 1996

BIOFILTRATION SYSTEMS,INC.

HIGH PERFORMANCE BIOFILTERS FOR WASTE WATER TREATMENT

ANAEROBIC BIOFILTER (ANBF)

Industrial Wastewater

Waste "strength" may be measured by five (5) day Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) or Total Organic Carbon (TOC). Any of these reflect the amount of carbon requiring removal in a given wastewater. Chemical Oxygen Demand (COD) describes the amount of oxygen required to completely oxidize all waste (primarily carbon) to carbon dioxide ($CO2$) and is usually used to describe the efficiency of biotreatment. Anaerobic biofiltration is generally applicable to the treatment of wastewaters exceeding 2000 mg/l COD.

Wastewater streams vary in strength from a few hundred milligrams per liter (mg/1) COD to hundreds of thousands of mg/l COD. Some examples of wastewaters are:

TYPE OF WASTE	COD
Aircraft Deicing / Anti-Icing Fluids	10,000 - 300,000 mg/l
Brewery Wash Waters	-2,000 mg/l
Can Manufacture (Solvent) Waste	-100,000 mg/i
Cheese Plant Wash Waters	2,000 - 5,000 mg/l
Cheese Whey	-60,000 mg/l
Cheese Whey Permeate	50,000 - 100,000 mg/l
Coating Industry (Latex paint)	-100,000 mg/ 1
Distillery Wastewater	-30,000 mg/l
Pharmaceutical Wastewater	10,000 - 100,000 mg/l
Potato Processing Wastewater	-10,000 mg/l
Soft Drink Processing Wastewaters	-2,000 mg/ 1
Vegetable Processing Brine Waste	-10,000 mg/ 1
Waste Beer	-60,000 mg/l
Winery Wastewater	-20,000 mg/l

Most of these wastewaters are extremely expensive to treat by conventional methods and many manufacturers incur very high surcharge costs for discharge to Publicly Owned Treatment Works (POTW). BFS provides a low cost pretreatment option for these manufacturers.

BFS has developed a system design that overcomes the deficiencies of others. BFS's biofilter systems are modular fixed film upflow-downflow type, and use a superior filtration/circulation System which allows for much higher active biomass retention and subsequently much higher waste loading, improved resistance to shock loading and simple operation.

REFERENCE PROJECT:

HAZARDOUS WASTE BIODEGRADATION

A MAJOR NATIONALLY KNOWN BREWERY

Our biosystems specialists were involved in the development, design and start up of an upflow, fixed film, anaerobic biofiltration system for the biodegradation of can manufacturing plant solvent waste. Paint coating solvent wastes had previously been collected, drummed and shipped to hazardous waste incinerators. This system saves the client over $300,000 per year in hazardous waste hauling, incineration cost and associated liabilities. Our company decided to improve and further develop the system and obtain a U.S. patent. The system has been in operation since 1989 and is working flawlessly.

BIOFILTRATION SYSTEMS, INC.

HIGH PERFORMANCE BIOFILTERS FOR WASTE WATER TREATMENT

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Industrial Wastewater

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Aerobic Biofilters are applicable to wastewaters of less than .2000 mg/l COD or having organic wastes too complex for anaerobic biofiltration.

Some examples of wastewaters for aerobic biofiltration-treatment. are:

TYPE OF WASTE	
Municipal Wastemeters	150 - 300 mg/l
Landfill Leachate	50 - 10,000 mg/l
Oil Operations Wastewater	1,000 - 100,000 mg/l
Solvent Contaminated Wastewater	50 - 2,000 mg/l
Contaminated Groundwater	5 - 2,000 mg/l
ANBF Pretreated Wastewater	50 - 500 mg/l

The BFS aerobic biofilter is a downflow fixed film reactor that uses proprietary technology to achieve high biodegradation rates. The aerobic system is capable of treating a wider variety of wastes than the anaerobic system including solvents, latex paint components, oils, grease and a number of hazardous wastes. Although the BFS aerobic biofifter produces more biosludge than the anaerobic version, it still produces over 20% less biosludge than conventional activated sludge aerobic systems due to the use of fixed film technology. Configuration of the BFS aerobic biofilfer is similar to the anaerobic system with the addition of the aeration system.

BFS modular aerobic units are designed for ease of maintenance and long life. Construction is, in most instances, reinforced fiberglass with (PVC) piping and specialized components. BFS units can be delivered anywhere and provide the most cost efficient and reliable system in existence.

BioFiltration Systems, Inc.

Sequencing Batch Reactor

Sequencing Batch Reactor systems represent a variation of the activated sludge process. Like any other activated sludge process, the SBR works by developing a mixed culture of bacteria which is effective in removing BOD, COD and nutrients commonly found in wastewaters.

The BFS SBR can treat a wide range of municipal and industrial wastewaters, at flows ranging from a few thousand gallons to millions of gallons per day.

The SBR is unique in its ability to act as an **equalization basin, aeration basin and clarifier** within a single reactor. The termination of flow and aeration during the treatment process provides perfectly quiescent setting conditions in the reactor, and permits even very fine particles to settle. Each reactor maintains its own treatment regime and all phases of treatment occur in each reactor.

SBR ADVANTAGES

Sequencing Batch Reactor systems offer many advantages over conventional flowthrough activated sludge systems, which may incorporate separate flow equalization, aeration and final clarifier basins.

1. <u>Lower Installation Costs</u> - each Sequencing Batch Reactor serves as an aeration basin and final clarifier, and provides the equivalent of flow equalization. This eliminates the need for separate structures for each unit process. The use of fewer structures in the treatment system generally results in lower construction and installation costs. Based upon a recent EPA cost comparison of a 1.0 MGD facility, the installation of an SBR represented a 1 0% costs savings as compared to an oxidation ditch treatment system.

2. <u>Consistent Effluent Qual</u>ity- the use of micro-processors allows the operator to adjust time and/or aeration/mixing based on organic loads and flow conditions to achieve required results.

3. <u>Easily Tolerates Variable Organic Loads</u> - the SBR easily tolerates variable hydraulic and organic loads since the SBR reactor serves as its own equalization basin. Mixed liquor solids cannot be washed out by hydraulic surges since effluent withdrawal is typically accomplished in a separate phase following the termination of flow to each reactor.

BIOFILTRATION SYSTEMS, INC.

HIGH PERFORMANCE BIOFILTERS FOR

AIR POLLUTION ABATEMENT

Odor/Air Emissions

Many municipal and industrial waste and wastewater processing facilities are plagued with nuisance and often hazardous odor emissions. A variety of compounds are responsible for odor problems, most of which are generated under aseptic or anaerobic conditions by micro-organisms. BFS's approach to the problem is straightforward. If micro-organisms generate the compounds responsible then micro-organisms must also be capable of destroying these compounds. The BFS Odor Biofilter utilizes this ability of microbes fixed on a filtration film to cleanse air streams of odor causing compounds. One of the most common problems is the generation of toxic and corrosive hydrogen sulfide gas (H2S) in wastewater processing lift stations and sludge holding tanks. BFS has demonstrated the efficiencies of biofiltration to remove hydrogen sulfide from the air in these facilities.

In many industrial situations odors are caused by volatile organic acids, which are also the result of uncontrolled aseptic, anaerobic conditions. BFS's modular biofilters have proven effective for the destruction and control of these compounds.

VOC

Many manufacturing processes produce byproduct Volatile Organic Compounds (VOC) that contribute to air pollution in the earth's atmosphere. VOC's are a wide range of organics from ethanol to complex organic solvents which are rapidly coming under environmental regulations and many manufacturing facilities are currently in need of cost effective means of eliminating or reducing sources of VOC. BFS's modular VOC Biofilters provide a highly cost-effective means of control without the use of hazardous chemical treatments (chemical scrubbers) used by many competitors.

Both Odor and VOC Biofilters are BFS's proprietary "gas phase" biotreatment technologies based on the same principle of the use of appropriate micro-organisms fixed on a thin reactor film for the direct treatment of problematic compounds carried in air (gas) streams. Both air scrubbing and biodestruction functions are carried out in a single biofilter.

The advantages of the BFS technology over other air pollution abatement technologies, include complete on-site destruction, no hazardous chemical additions, low maintenance and operating costs, energy efficiency, low capital costs, a natural means of treatment, ease of expansion and simplicity.

STATE OF THE ART PROCESS

FOR THE TREATMENT OF

AIRFIELD DEICE / STORMWATER RUN-OFF

BioFiltration Systems™, Inc.

1800 Second St.
Suite 808-13
Sarasota, Florida 34236
(941)953-5200 Fax 953-5353
Toll Free 1-888-Bio-Fltr

As everyone involved in airport management is aware, the federal government has mandated several programs designed to improve the quality of streams and rivers. Discharge to streams and rivers of surface water run-off now requires the discharging entity to apply for, and obtain an NPDES (National Pollution Discharge Elimination System) permit from the EPA (Environmental Protection Agency). The EPA has tightened the enforcement of many rules concerning the discharge of pollutants, and discharge of deicing fluids is of particular concern to regulators.

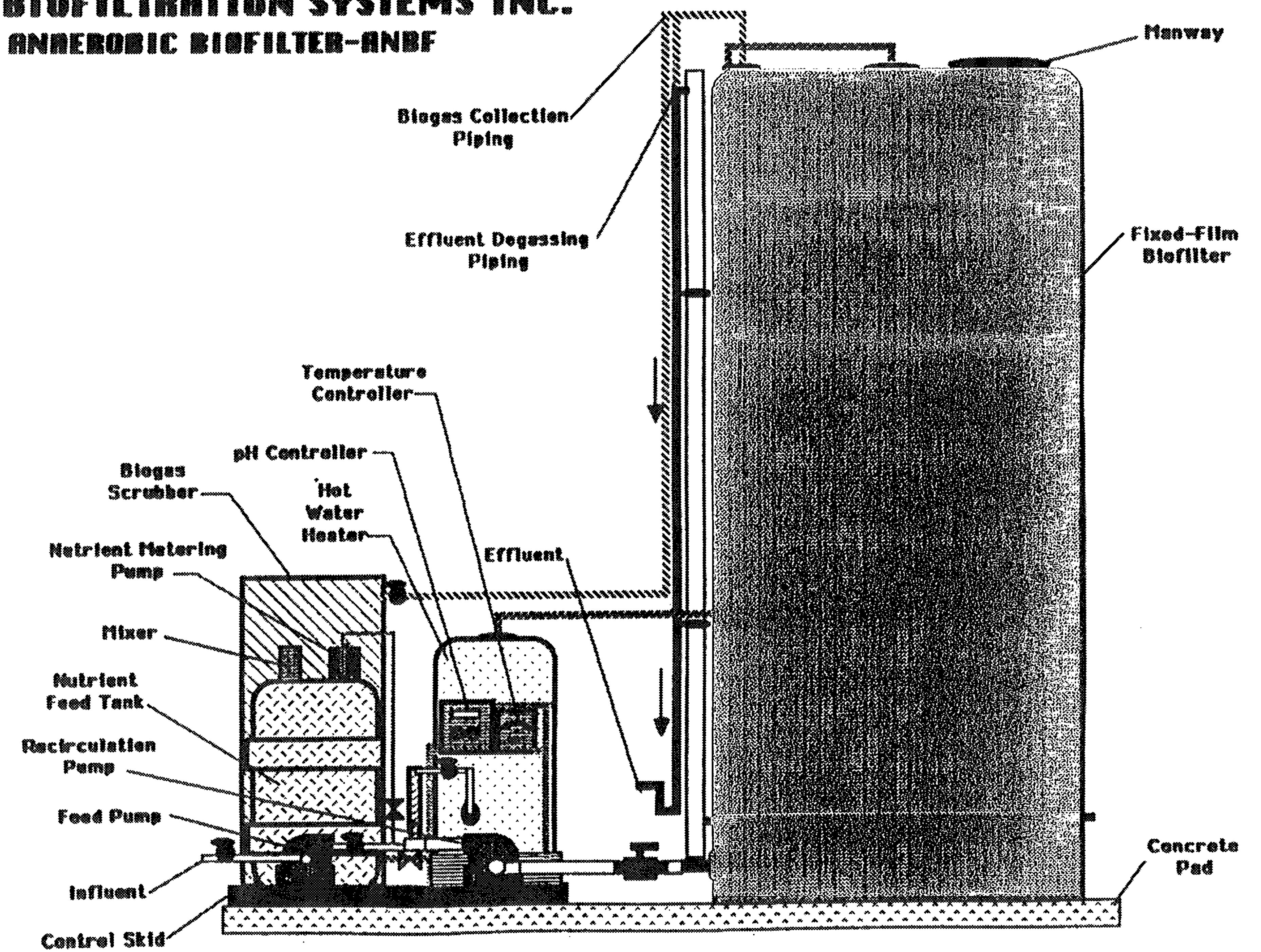
The main ingredients of commercial deicers ethylene and propylene glycol, are high oxygen demand chemicals. This means, in the presence of oxygen dissolved in water, the chemical captures free oxygen, depriving fish and other aquatic plants and animals of this life-giving element. If these chemicals are allowed to enter a waterway, the natural health of the waterway deteriorates and pollution can kill yet another river or stream.

Aircraft deicing compounds are formulated for both Type I and Type II deicing. That is, Type I deicers are formulated from ethylene and diethylene glycols, and are used for immediate or short term deicing. Type II deicers are generally propylene glycol, which tends to stick to aircraft surfaces and provide extended deicing activity. Type II will shed from aircraft surfaces during take off. All of these activities, although necessary from a safety standpoint, result in the distribution of these various glycols into the environment.

The problem then, as mentioned above, becomes the potential pollution of waterways and groundwaters with glycols. Many airports are currently evaluating and developing plans for the management of contaminated stormwater run-off.

This has presented airports with a difficult and complex environmental problem. Some facts have emerged. Deicing operations result in both highly contaminated storm-event waters and less severely contaminated general run-off waters. During a winter storm event, deicing may take place near gates and/or hangers, or possibly at the ends of taxiways. Some commercial airports are attempting to locate deicing activities near the ends of runways in order to provide deicing where it is needed most, and to provide a means of collecting highly

BIOFILTRATION SYSTEMS INC.
ANAEROBIC BIOFILTER-ANBF



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concentrated wastewater streams. Research done by (BFS) and its engineering associates indicates that deicers are used in thirty to fifty percent concentrations, and that where these are applied in confined locations during cold weather storm events (snow, sleet, etc.), the resultant collected run-off can contain glycol concentrations of ten to twenty percent or more. In more disperse applications and in wetter weather, concentrates can fall to the one percent or less range in stormwaters. All of these waters are potential environmental threats.

TREATMENT OPTIONS

After the glycol and precipitation runoff has been collected in storage areas, the more difficult problem of disposal of the glycol compounds is approached. Several options were considered and are enumerated below.

A. DISTILLATION has been utilized at other installations throughout the world and is being considered at still more airports. Our investigation has shown that for the minimum two or three cut still that would be required at most airports, the hardware cost would be expensive, compared to the cost of biofiltration equipment. This particular installation would require additional engineering as there are, generally, no "off the shelf" distillation units that could be purchased and installed. The further detractions of distillation are the cost of energy to accomplish this process, and the general operation and maintenance costs. Finally, the glycol compounds produced will require additional processing to assure proper application and use characteristics as well as the overriding issue of product liability. Distillation can be considered in geographic areas where reuse liability is diminished such as coal unit train deicing and industrial applications. Other reuse avenues often expose the environment to the same risks that are being addressed by this program. Distillation is not an economically viable approach at this time.

B: MECHANICAL SEPARATION is also being employed at some installations in the United States. The use of reverse osmosis is touted by some as a method to separate the glycol compounds from the precipitation. Our investigations have shown that the molecular size of the glycol compounds are too close to water to make filtration viable from a technological standpoint. Separation that can be accomplished by filtration methods are not discreet enough to assure the quality of the discharge water nor the purity of the glycol products. We are also concerned about membrane life when considering the background contaminants that will be present when processing the runoff fluids. Mechanical separation is not technically reliable enough to be a viable approach at this time.

C. ANAEROBIC BIOFILTRATION. The BioFiltrations Systems, Inc. (BFS) patented Anaerobic Biofilter is designed for the cleaning of these waters for discharge, and to obtain useful energy from the contaminant glycols. The BFS modular biofilter converts organic components, such as waste glycols to carbon dioxide and methane gas. The anaerobic removal of pollutants results in very little sludge generation, and appears the most economic alternative for cleansing these run-off waters. The cleaned water may be discharged to Publicly Owned Treatment Works (POTW), or directly to public waterways under a National Pollution Discharge Elimination System (NPDES) permit. In the first case a single BFS Biofilter may be used. In the second, where discharge standards are more stringent, a two-stage patented biofilter will be employed to meet NPDES requirements. As

DEFINITIONS

BIOFILTER (BF)
The biofilter or biofiltration process provides a dynamic means of filtering and simultaneously destroying waste components in a liquid (aqueous) or air stream by entrapped micro-organisms on the filter media. The micro-organisms are responsible for the destruction of waste chemicals and "cleaning"of the fluid.

AEROBIC BIOFILTER (ABF)
The aerobic biofilter can be used to treat wastewater streams that carry waste components (that is, the cause of COD or BOD5) that are either too complex for anaerobic micro-organisms to metabolize, or are of too low a concentration to provide effective **use** of the anaerobic biofilter (ANBF). The aerobic biofilter (ABF) will produce over ten times the amount of biosolids (waste activated sludge) that the anaerobic biofilter (ANBF) produces.

ANAEROBIC BIOFILTER (ANBF)
The apparatus used to entrap methanogenic consortia for the process of treatment or reduction of COD (or BOD5) in wastewaters. For many industrial wastewaters, the ANBF is the most cost effective system available to reduce effluent wastewater COD and city surcharges usually associated with organic-laden wastewater discharge. The ANBF is a form of wastewater pretreatment, usually reducing waste strength by over 90%.

BOD5 (BIOLOGICAL OXYGEN DEMAND - 5 DAY TEST)
Commonly used by municipalities to attempt to describe the amount of oxygen demanding components in a wastewater sample which would be BIOLOGICALLY OXIDIZABLE. The test is performed using a microbial inoculum and measuring oxygen uptake over a 5-day incubation period. BOD5 does not necessarily estimate the COD of a wastewater, but tells only the demand readily required by micro-organisms under the conditions of the test. It is designed to estimate the 'potential" for eutrophication of a public waterway, should the wastewater be added to it untreated. BOD5 should **not** be used directly for treatment process control. It is generally expressed as mg BOD5 per liter of wastewater.

In many industrial wastewaters there exists a rough correlation between BOD5 and COD of about 0.7 in untreated waters. The ratio tends to drop significantly after treatment.

COD (CHEMICAL OXYGEN DEMAND)
The oxygen equivalent required to completely oxidize **chemically** all organic and other oxidizable components of a wastewater sample. Generally expressed as mg COD per liter of wastewater.

HYDRAULIC RETENTION (HRT)

The HRT is determined by the flow of liquid to the fixed volume of the BF. If the Hydraulic load-rate is 40,000 gallons/18,000 gallons reactor volume/day or 2.22 gallons/gallon/day then; 24 hours/2.22 = 10.8 hours HRT. HRT can also be calculated by inverting the equation; 18,000 gallon reactor volume/40,000 gallons/day x 24 = 10.8 hours HRT.

LITER (1)

Metric measure of liquid volume (approximately one (1) quart). There are 3.785 liters in each U.S. gallon at Standard Temperature and Pressure (STP).

MELLELITER **(ml)**

1 /1,000 of 1.0 liter. Also knovm and defined as 1 cubic centimeter (1 cc). There are 1,000 mls or cc in one liter at Standard Temperature and Pressure (STP).

GRAM (g)

The mass of one cubic centimeter (cc) of water at Standard Temperature and Pressure (STP). 'Mere are 454 grams in one pound.

M|ILLIGRAM (mg)

1 / 1,000 of a gram. There are 1,000 grams in one (1) kilogram of mass at Standard Temperature and Pressure (STP).

pH (POWER OF THE HYDROGENION)

A measure of acidity (pH 0-7) or alkinity (pH 7-14) of a wastewater sample. pH is a logarithmic function, therefore every decrease of 1.0 unit of pH Increases the acidic nature of the solution (H +) by an order of magnitude(factor of 10).

EUTROPHICATION ("GOOD FOOD")

The addition of wastewaters high in organic and other oxygen demanding components (e.g- NH3-N) to natural waterways results in rapid oxygen depletion of those waters with concomitant fish kill and further imbalance of the natural ecosystem.

VOC

Volatile Organic Compounds. Organic (carbon-containing) compounds contributing to air pollution.

PRESENTATION

DE-ICING TECHNOLOGY CROSSFEED
WASHINGTON ,D.C.
AUGUST 21, 1996
1645-1715 HOUR

1. INTRODUCTION

a. TC

b. AK

c. Thank Carroll Herring

d. Last to speak - best for last - discuss concept rather than technical because of time constraint - mind can absorb only as much as seat of pants can stand.

e. Varied audience, military, civilian, vendors -- Will discuss basic concepts but not technical issues -- will discuss technicallities and specific problems on an individual basis and through phone, or fax requests.

f. We are with BFS from Sarasota Fl.

g. We have been in business since 1992 developing processes to treat waste water streams in various industries. Landfills, can manufacturing, and many other industries.

h. We have developed a process to harness bacteria to specifically treat glycol and associated effluent. This was done in conjunction with a major can manufacturer who needed to treat a glycol based solvent.The BOD / COD ratings on paint solvent is comparable to deicer . The process developed to treat this waste has been operational at a DOE certified facility since 1989

and treats the waste to under 250 mgl BOD which meets the waste water requirements and can be further treated down to a level for reuse . This basic technology has now been perfected and patented by BFS specifically for the treatment of deicing fluids and all associated runoff.

The treatment is done through a Biofilter which means;

a. The effluent is put in contact with a Bacteria contained in media in a tank that biodegrades this waste and turns it into methane gas and carbon dioxide.

b. Bacteria is not something new as it has been around since the beginning of time and is older than the dinosaurs.

c. An article in National Geographic dated August 1993 states:

   1. Titled " Teaching old bugs new tricks"

   2. Talked about what bugs do ie. ferment bread, beer, cheese, yogurt , create man made insulin for diabetics, snow machines etc., etc.

   3. Only one microbe in a thousand is a pathogen -- what we think of as a germ. The rest, neither we nor the planet could live without. They make what we want and they get rid of what we don't want. They are the work horses of biotechnology.

   4. Today each of you carry about a quarter pound of bacteria. Billions are helping digest your last meal and perhaps excavating a cavity where your toothbrush fails to reach.

Therefore, bacteria is nothing new ; only the ability to harness a specific

bacteria in a controlled format and properly nurtured to maximize its ability to treat a specific waste , this is new and this is what BFS does.

2. WHERE INDUSTRY IS TODAY

a. AAAE conference just completed.

1. Very informative with lots of information from many varied sources.

2. From a treatment standpoint anaerobic Biotreatment seemed to garner alot of support, however this is not necessarily the final answer as some treatment may need to be aerobic and/or anaerobic and disc and or sand filters may also be necessary to treat total suspended solids. Also other treatment options do exist.

b. Distillation

1. Arco report (a major supplier of glycol)

Objective comparison between BioFiltration and distillation

Distillation may work if circumstances the best like Denver new airport and very high volume. The variables will always exist as to what the operational costs will be in the future, what the after market for reclaimed glycol will be, and most importantly what changes in regulations and liability will take place.

c. POTW

1. POTW and GLYCOL don't mix report.

2. Essentially an Aerobic system with the major drawback being sludge production (aerobic 50% anaerobic 2.5%) and high load demands for short periods of time are not in the best interest of the facility. 100

gallons of glycol are equal to the sewage treatment necessary for a city of 5,000 people.

3. Areas of the country where POTW demand is declining ie Buffalo NY they will probably be able to handle the effluent for the long term at reasonble rates.

d. Reverse Osmosis

1. Difficult to operate effectively because the molecular size of glycol is too close to water. Therfore the membrane must be under high pressure which is expensive to operate and is vulnerable to foreign material such as brake linings etc.

e. Many others not worth discussing such as incineration, deep well injection.

f. BFS(discuss later)

3. YOUR OBJECTIVE IS

a. Develop an Air Force strategy to comply with the Clean Water Act, State and local regulations.

b. Develop a plan that will work for multiple locations that have a quagmire of variables.

4. YOUR PROBLEM IS

a. Each military installation has a unique set of problems

1. weather

2. topography

3. local government (regulations, odor control etc.)

4. # flights

5. type aircraft

6. site configuration (for storage pond, tank etc.)

7. ability to collect runoff (existing storm, detention ponds etc.) which will effect the collected effluent concentration levels.

8. Type of deicing chemicals

Can have more than one type of chemical being used at same time

Potential for future change to new chemicals

A system may be designed for one product then the product gets changed

b. The military in general is in a state of flux

1. Opening, closing , consolidating locations.

2. Changes at installations ie. move C5As from Dover and replace with a fighter wing.

3. Temporary locations ie. Desert Storm, Bosnia.

c. Environmental regulation has many influencing factors

1. EPA

2. Local regulations

3. Local capacity for treatment (POTW capacity, future local growth/contraction)

4. Type deicing products to be used

5. Disposal liabilities (transportation, reuse, cradle to grave)

5. YOUR SOLUTION IS

a. FLEXIBILITY

1. Having a system that can be adjusted to be pretreatment or treatment.

SOLVES CHANGING REGULATIONS

2. Having a system on site that can treat multiple products

SOLVES CHANGING DE-ICING CHEMICALS

SOLVES USE OF MULTIPLE DE-ICING CHEMICALS

SOLVES MULTIPLE CONTAMINANT (glycol, jet fuel etc.)

3. Having a system on site that can be economically changed to increase or decrease throughput capacity.

SOLVES CHANGING VOLUMES

SOLVES RELOCATION / TEMPORARY USE

b. ON SITE TREATMENT

1. Eliminates off site regulations and potential liabilities (Cradle to Grave)

2. Total control, no off site variables to contend with

3. Can adjust system to meet any changes in volume or contaminate.

4. Can set up system to be pretreatment or treatment.

6. OUR SYSTEM AT BFS

1. Hardware

a. Pretreatment (treat down to 250 mgl BOD or to POTW specs)

Treatment (treat down to reuse level)

b. Modular (Can be transported in C130, C5A) Increased or decreased depending on requirements

c. Aerobic / Anaerobic

2. process

a. Bacteria biodegrades contaminate and converts it into Methane gas and carbon dioxide.

b. Essentially RECYCLE the waste stream into a usable energy source that is used to operate our system.The excess gas can be used at the base or sold to outside sources. As Webster dictionary says recycle is " to pass again through a series of changes or treatments to regain material for human use."

c. If necessary we can intall an ultraviolet censor in the influent line that will divert the waste stream at the first sign of glycol so the glycol free flow in the waste stream can be sent to the storm system until deicing occurs eliminating unnecessary treatment. This same censor will also test the output from our system to verify compliance to the pre established parameters.

d. An in place system can be started up in two to four weeks depending on the parameters established, as bacteria will double every 20 minutes creating 1.2 sextillion in 72 hours.

3. history

a. Technology developed at a major can manufacturing plant that uses a glycol based solvent which is comparable in BOD and COD to airport deicer. This system has been in operation since 1989 and takes the BOD and COD down to

448

250 mgl or less.

b. An airport prototype was set up and operated with test results being conducted by an outside independent test lab,reducing the COD by 99.9999047%.

c. Bacteria is a natural process that occurs every day in nature and what we have done is controlled this process to speed up nature work.

4. throughput -- determined by individual needs, however from the information I heard this week the military used 138,000 gallons of glycol last year; will generally require inexpensive small multi stage units.

5. cost, hardware / operational -- determined by individual needs but no need for energy

6. advantages -- modular, on site, low operational cost.

6. SUMMARY

1. Call us a recycler , a biotech company or whatever the end result is

a. An economically viable solution to a complex ever changing problem.

a. treat multiple deicing wastes at varying concentrations

b. flexible for change ; whether it be the product , volume, location

c. We feel our system is very viable for most military scenarios.

CONTACT LIST

One of the most important things we did in conjunction with this effort is to develop a listing of individuals who are knowledgeable in de-icing matters for inclusion in the minutes. The purpose of this list is to be a reference tool to be used by Air Force personnel who are working de-icing problems. Reference to this list will provide the problem researcher with the names of individuals who can be contacted for discussion relative to the problem.

included in this list are individuals whom we had occasion to become familiar with as we did our research for the de-icing technology crossfeed. Some of the names on the list were extracted from old minutes of meetings pertaining to de-icing. Others were found in the literature. Others were provided by word of mouth by people who had worked de-icing problems earlier. Still others were extracted from company literature sent to us after we ran an add in the Commerce Business Daily. Still others were added from business cards provided to us during the Annual De-icing Conference and Exposition.

Obviously, the list is not complete but it provides a good point of departure for individuals who have to work de-icing problems.

The list was last updated on 16 Sep 1996.

De-cing Contact List

In today's Air Force, communication is key. This listing is intended to make communication easier.

This listing identifies people who are knowledgeable about de-icing and can be contacted for ideas about how to best work de-icing problems.

Included in the list are people who work for the military services, other Government organizations and for private industry.

Index of Military Contacts In this section, names are listed by organization or discipline. In the next section, the names are listed alphabetically and phone numbers, fax numbers and e-mail adressess are provided.

Wright-Patterson AFB

Al Baca (contr)
Mike Bickett
Terry Black
Teresa Finke
Carroll Herring
Denny Jarvi (contr)
Jerry Mongelli (contr)
Maj Kent Nonaka
Lt Col Gil Wendt

Air Force R&D Contacts

Tom Bond
Capt Gretchen Brockfeld
Capt Mike Chipley
Capt Jeff Cornell
Dave Ellicks
Msgt Mary Fields
Capt Paul Fronapfel
Dr Len Haslim
Dr Fred Hedberg
Dr Walt Kozumbo
Dick Kinze
Dr David Mattie
Lt Dennis O'Sullivan
LTC Rich Perkins
Maj Al Rhodes
1 Lt Uduak Udo-Aka
Lt Col Alan Weiner
Jody Wireman
Dr John Zuk

HQ ACC Langley AFB

Gary Bagshaw
Chief George Ellison
Drew Francis
CMSgt Phil Granier
Charlie Nault (contr)
Gary Nault

HQ AMC Scott AFB

SMSgt Garrick Burnie
Capt R Murphy
Maj Gary Phillips
CMSgt Joe Proffitt
H Sanghavi
Capt Gregg Sims
CMSgt Dave Young

HQ USAFE Ramstein AFB

MSgt Darrell Poff
Debby Locklair

HQ PACAF Hickam AFB

Mano Husain
Gorden Kawelo

AFMC Single Manager Contacts

Jim Bean	*KC-10*
Greg Garcia	*C-5*
Rick Jones	*C-130*
Maj Spacy	*C-17*
Ralph Tyner	*C-141*

AFMC Center Environmental Managers

OC-ALC/EM
OO-ALC/EM
SA-ALC/EM
SM-ALC/EM
WR-ALC/EM
ASC/EM
ESC/EN-2
HSC/EM
SMC/SDZB
AGMC/EM

ALC/TI Technical Management and Engineering Support Managers

OC-ALC/TI
OO-ALC/TI
SA-ALC/TI
SM-ALC/TI
WR-ALC/TI

Reserve and ANG Contacts

CMSgt Paul Antkowiac
Capt Dave Arthur
SMSgt Robert Boyer
Col Alan Clune
Wayne De Bor
1Lt Bob Huelsman
Skip Igo
Maj Lynn Jobes
RickJozwick
SMSgt Paul LaCourciere
Cathy Makofski
Capt Mike Moore
Robert Moesline
Maj Pedro rivas
Susan Stell
John Tower
1 Lt Jack Wall
Paul White
Kari Wildgruber
Alvin Zatezalo

Air Staff Contacts

Keith Glass (spt contr)
Lt Col Sherm Forbes
Lt Col John Garland
Maj David Guadalupe
Norm Guenthen
Lt Col Judy Munley
Jay Shah
Ray Vaselich

Elmendorf AFB Contacts

Dan Collins
SMSgt Bruce Cremer
Joseph Cross
Bob Giroux

Minot AFB Contact

CMSgt Wayne McGothlin

Offutt AFB Contacts

Ed Lueninghoerner
Frank Tabor

Grand Forks AFB Contact

Rose Fraley

Pope AFB Contacts

Bob Dalzell

SA-ALC Contacts

Brian Ballew
john King
Pete Palmer
Jim Vasil
Gus Zachariades

HSC Contacts

John Biggs
Lt Col Brian McCarty
1 Lt Yvonne Spencer

AFLMA Contacts

Maj Norm Murray
MSgt Stanley Mynczywor

AF Safety Agency Contacts

Britt Covington
Ron McGreggor

AFCESA Contacts

SMSgt Earl Labonte
Dave Wagner

AFCEE Contacts

Johnny Combs
Col Patrick Fink
Carl Leighman
Skip Sowards
Vic Verma

AFFTC (Det 3 Contact

Tim Johnson

AFCSA Contact

Eric Eklund

Army Contacts

Bob Eaton
Jerry Oliver
Paul Pantelis
Dr Charles Ryerson
Maj Dave Sheets

Navy Contacts

Dave Asiello
Phil Bevilacqua
Dave Brock
Pat Doyle
Paul Helms
Walt Koehle
Maj Mike Landryr
Lt Felipe Lopez
Tami McVey
Pete Mullenhard
Jim Muller
Bob Sandoval
Paul Swindel
ASC (AW) Jack Yon
John Ziegra

Marines Contact

Mahlon Yokley

Coast Guard Contact

Richard Peri

DLA (DSCR) Contact

Cliff Myers

Index of other US Government Contacts

EPA Contacts

Don Brown
Kelly Conrad
Nancy Cunningham
Bill Swietlik

FAA Contacts

Katherine Hakala
George Legarreta
Wayne Marsey
Charles Masters
Nelson Miller
Tom O'Brien
Edward Pugacg
Cynthia Rich
Kenneth Stone
Larry Youngblut

Nat'l Transportation Safety Board

Robert Macintosh

Index of Canadian Government Contacts

Canadian Armed Forces Contacts

Lewis Cocks
Bob Danahy
Sgt R. A. Lawless

Transport Canada Contact

Alec Simpson

Environment Canada Contact

Robert Kent

Government De-icing Contacts (includes US and Canada) By Name, Address, Phone Number, Fax Number, E-Mail, etc

Note: an asterisk indicates person attended the 1996 de-icing crossfeed

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Maintenance of aircraft GSE

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LSS superintendent and resident expert on de-icing

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envirinment logistics

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Research in ice protection systems

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Data base on wetland treatment system

455

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Zero discarge in stormwater runoff
Case study containment system

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Air Command environmental officer

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Superintendent Elmendorf

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Regional environmental manager
Checking with state regulators about what is required by each state

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en route maintenance superintendent

JOSEPH CROSS *
3CE/CEORH
BLDG 32-187 ARCASIA AVE
ELMENDORF AFB AK 99506
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K Acetate primarily used. Not deplete oxygen. Don't use in freezing rain. Too much slimes up runway.

NANCY CUNNINGHAM
US EPA OFFICE OF WASTEWATER MANAGEMENT
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MAIL CODE 2403
WASHINGTON DC 20460
202-260-9535 FAX: 202-260-1460

BOB DALZELL *
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POPE AFB NC
910-394-1654

BOB DANAHY
8 WING
TRENTON ONTARIO **CANADA**
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Use 70% ethylene and 30% propylene mixed 60-40 with warm water.

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Alaska currently has no glycol regs

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De-icing and anti-icing requirements and procedures

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Research scientist

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Funding basic research for deicing alternatives at colleges and universities

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de-icing crossfeed project officer

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rhuelsman@wimke.ang.af.mil
Wisconsin controls de-icing fluid that leaves base

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SKIP IGO *
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aircraft maintenance flight chief

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A/C maintenance environmental mgr

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HEAD, AQUATIC GUIDELINES AND ASSESSMENTS SECTION
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Environ poc / navy glycol use

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De-icng of runways

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Runway friction test for deicers. Has worked well with AF.

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civil engineer

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Chief, Environmental Initiatives Branch

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Chemist/Integrated manager for de-icing fluid technical quality, supply procurement issues.

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DSN 596-4581 FAX 596-4638
smynczywor@b205s1.ssc.af.mil
Performed deicing study in 95

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LANGLEY AFB VA 23665-2769
DSN: 574-3668 FAX: 574-8033
naultg@hqaccce.langley.af.mil
Funds water compliance de-icing solutions for ACC bases.

MAJ KENT NONAKA *
AFMC/CEVV
4225 LOGISTICS AVE
WRIGHT-PATTERSON AFB OH 45433
DSN: 787-7414 FAX: 986-1650
nonakak@afmcce.wpafb.af.mil

TOM O'BRIEN
***FAA** TECH CEN*
ATLANTIC CITY INT'L AIRPORT
ATLANTIC CITY NJ 08405
609-485-4129
Special assistant

JERRY OLIVER *
12 AV BATTALION
DAVISON ARMY AIRFIELD
FT BELVOIR VA 22060
DSN 656-7110 FAX: 703-806-7538

LT DENNIS O'SULLIVAN
AL/EQS-OL
139 BARNES DR, STE 2
TYNDALL AFB FL 32403-5323
DSN 523-6232 FAX: 523-6064
Replaces Maj Rhodes as deicer POC
dennis.osullivan@ccmail.aleq.tyndall.af.mil

PETE PALMER *
SA-ALC/LDEE
485 QUENTIN ROOSEVELT RD STE 7
KELLY AFB TX 78241
DSN: 945-0239 FAX: 945-8606
ppalmer@sadis01.kelly.af.mil
Cognizant engineer for aircraft de-icing equipment.

PAUL PANTELIS *
AATD/AMSAT-R-TL
FT EUSTIS VA 23604-5577
DSN: 927-5777 FAX: 927-3029
pantelis@eustis-aatds1.army.mil
Army aircraft cleaning and de-icing equipment R&D.

RICHARD PERI
HQ USCG (G-EAE-37)
2100 SECOND ST SW
WASHINGTON DC 20593-0001
202-267-0796
r.peri/g-eae2@cgsmt.comdt.uscg.mil
JDEP rep USCG doesn't de-ice much
Uses ethylene and propylene C-130s

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LTC RICH PERKINS *
AFLO CODE U MS210-6
NASA AMES RESEARCH CENTER
MOFFET FIELD CA 94035
DSN 359-5832 FAX: 415-604-0967
lt_col_rich_perkins@qmgate.arc.nasa.gov
AF liaison officer for Wright Labs

MAJ GARY PHILLIPS
AMC/DOTK
402 SCOTT DR UNIT 3A1
SCOTT AFB IL 62225-5302
DSN: 576-5924 FAX: 576-2773
phillipg@hqamc.safb.af.mil
Base Ops aircraft de-icing decisisons

MSGT DARRELL POFF
HQ USAFE/LGMM
RAMSTEIN AFB GE
APO AE 09094
poffd@usafe5.ramstein.af.mil

CMSGT JOE PROFFITT
AMC/DOTK
402 SCOTT DR UNIT 3A1
SCOTT AFB IL 62225-5302
DSN: 576-5924 FAX: 576-2773
proffitj@hqamc.safb.af.mil
Base Ops aircraft de-icing decisisons

EDWARD PUGACG
PROJ MGR
***FAA** TECH CENTER*
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ATLANTIC CITY NJ 08405
609-485-5707

MAJ AL RHODES
AL/EQS-OL
139 BARNES DR, STE 2
TYNDALL AFB FL 32403-5323
DSN 523-6232
al.rhodes@ccmail.aleq.tyndall.af.mil
Env. compatible deicing programs Will provide navy contacts for modified monosaccharides and methyl cellosolves

CYNTHIA RICH
FAA
800 INDEPENDANCE AVE SW
ARP-1
WASHINGTON DC 20591
202-267-9471
Ass't administrator for airports

MAJ PEDRO RIVAS *
317AS/DOLT
105 EAST HILL BLVD
CHARLESTON SC 29404
DSN: 673-2436 FAX: 673-5867
C-17 reserve pilot Flies for Delta

DR CHARLES RYERSON *
US ARMY CRREL
72 LYME ROAD
HANOVER NH 03755-1290
603-646-4487 FAX: 603-646-4644
cryerson@crrel.usace.army.mil

BOB SANDOVAL *
NAVAL FACILITIES ENGINEERING SERVICE CENTER
CODE ESC421
1100 23rd AVE
PORT HUENEME CA 93043-4370
DSN: 551-1466 FAX: 805-982-4304
bsandov@nfesc.navy.mil
Pollution prevention technical development

H SANGHAVI *
HQ AMC/CEVCM
507 A STREET
BLDG P-40 WEST
SCOTT AFB IL 62225-5022
DSN: 576-5764 ext 516 FAX: 576-2693
sanghavh@hqamc.safb.af.mil
AMC water program manager for compliance, infrastructure and O&M issues.

JAYANT SHAH *
HQ USAF/CEVC
1260 AIR FORCE PENTAGON
WASHINGTON DC 20330-1260
DSN 227-2797 FAX 227-3378
shahj@afce.hq.af.mil
Air Force water program manager.

MAJ DAVE SHEETS
AMCIO-EQM
ROCK ISLAND IL 61229-6000
DSN: 793-1958 FAX: 793-1457
dsheets@ria-emhz.army.mil
JDEP rep

CAPT GREG SIMS *
AMC/DOTK
402 SCOTT DR UNIT 3A1
SCOTT AFB IL 62225-5302
DSN: 576-5924 FAX: 576-2773
simsgr@hqamc.safb.af.mil
base ops

ALEC SIMPSON
MANAGER, ENVIRONMENTAL PROTECTION
ENVIRONMENT CANADA
PLACE DE VILLE
OTTAWA ONTARIO K1A 0N8
CANADA
(613) 990-0512 FAX: (613) 990-9589

SKIP SOWARDS
PRO-ACT
HQ AFCEE/EP
8106 CHENNAULT RD, BLDG 1161
BROOKS AFB, TX 78235-5318
DSN 240-4243
proact@osiris.cso.uiuc.edu

1 LT YVONNE SPENCER *
HSC/YAL
8107 13th STREET
BROOKS AFB TX 78235-5218
DSN: 240-6354 FAX: 240-2993
spencery@diamond.brooks.af.mil

SUSAN STELL *
AFRES/CEVC
ROGINS AFB GA 31098
DSN: 497-1078 FAX: 497-0108
sstell@wrb.afres.af.mil
Concerned about environmental impacts in AFRES northern bases

KENNETH STONE
FAA
513-569-7474
pollution prevention technology

BILL SWIETLIK
US EPA OFFICE OF WASTEWATER MANAGEMENT
401 M St SW
Mail Code 2403
Washington DC 20460
202-260-9529 FAX: 202-260-1460
Issues storm water regulations

PAUL SWINDELL *
NAWC A/C DIVISION CODE 11X71LB
LAKEHURST NAS NJ 08733-5052
DSN: 624-1926 FAX: 624-4029
@lakehurst.navy.mil

FRANK TABOR
CIVIL ENGINEERING
OFFUTT AFB NE
DSN 271-5369
PM for deicing pad installed at offutt

JOHN TOWER *
171ARW/EM
300 TANKER ROAD
PITTSBURGH IAP
COREAPOLIS,PA 15008-4257
DSN: 277-7640 FAX: 277-7221
jtower@papit.ang.af.mil

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1 LT UDUAK UDO-AKA (ITA) *
WL/MLSE
WRIGHT-PATTERSON AFB OH 45433
DSN: 785-3953 FAX: 476-4378
udoakaui@ml.wpafb.af.mil
De-icing R&D at WL.

RAY VASELICH *
SAF/AQRE
8804 LAKE HILL DR
LORTON VA 22079
703-690-1986 FAX: 703-690-4572

JIM VASIL
SA-ALC/SFTT
KELLY AFB TX 78241
DSN 945-7613 FAX: 945-9964
jvasil@sadis01.kelly.af.mil

VIC VERMA *
AFCEE/CCD-A
77 FORSYTH STREET SW STE 295
ATLANTA GA 30335-6801
404-331-0590 FAX: 404-331-2537
vverma@afceeb1.brooks.af.mil

DAVE WAGNER
AFCESA/CEOM
139 BARNES DR STE 1
TYNDAL AFB FL 32403
DSN: 523-6388 FAX: 523-6499
wagnerd@afcesa.af.mil
De-icing runways

1 LT JACK WALL *
151 ARW/EM
765 NORTH 2200 WEST
SALT LAKE CITY UT 84116
801-595-2157 FAX: 801-595-2178
jwall@utslc.ang.af.mil

DON WEBB
OC-ALC/EM
7701 SECOND ST
TINKER AFB OK
DSN: 336-2157 FAX 336-4381
dwebb@po25.tinker.af.mil

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allan_weiner@ccmail.aleq.tyndall.af.mil

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ROBINS AFB GA 31098
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pwhite@wrb.afres.af.mil

KARI WILDGUBER
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3500 FETCHET AVE, BLDG R-47
ANDREWS AFB MD 20762
DSN: 278-8197 FAX: 278-8151
Pollution Prevention

JODY WIREMAN
AL/OEMH
2402 E DRIVE
BROOKS AFB TX 78245-5114
DSN: 240-6123 FAX: 240-2315
Toxicology review for QPL
jody.wireman@guardian.brooks.af.mil

MAHLON YOKLEY
MARINES
DSN: 582-4594
JDEP rep

ASC(AW) JACK P YON *
NAS BRUNSWICK, AIMD
1251 ORION ST SOUTH
BRUNSWICK ME 04011-5000
DSN: 476-2138 FAX: 476-2306

CMSGT DAVE YOUNG
HQ AMC/LGAB
402 SCOTT DR UNIT 2A2
SCOTT AFB IL 62225-5308
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youngd@hqamclg.safb.af.mil
LG environmental matters

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FAA FLIGHT STANDARDS SERVICE
800 INDEPENDENCE AVE, S.W.
WASHINGTON DC 20591
202-267-3755
Expert in de-icing and anti-icing requirements and procedures

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KELLY AFB TX 78241
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czachari@sadis05.kelly.af.mil
Air Force de-icer T.O. manager

ALVIN ZATEZALO *
911 AW
316 DEFENSE AVE STE 101
CORAPOLIS PA 15108-4403
412-474-8191 FAX: 412-474-8709

JOHN ZIEGRA
PUBLIC WORKS DEPT
ENVIRONMENTAL DIVISION
400 ORION ST
BRUNSWICK NAS ME 04011
207-921-9445 FAX: 201-921-2649

DR JOHN ZUK *
NASA-AMES
MOFFETT FIELD CA 94035
415-604-6568
Project officer for new type II fluid

ALC /TI Technical Management and Engineering Support Managers

OC-ALC/TI
3001 STAFF DRIVE, STE 2AF69A
TINKER AFB OK 73145-3001
DSN: 336-3184

OO-ALC/TI
5851 F AVE
HILL AFB UT 84056-5713
DSN: 777-4504

SA-ALC/TI
450 QUENTIN ROOSEVELT RD
KELLY AFB TX 78241-6416
DSN: 945-7391

SM-ALC/TI
5225 BAILEY LOOP
MCCLELLAN AFB CA 95652-2510
DSN: 633-2010

WR-ALC/TI
420 SECOND ST., STE 100
ROBINS AFB GA 31098-1640
DSN: 468-4930

AFMC Center Environmental Managers

OC-ALC/EM
7701 SECOND ST., STE 220
TINKER AFB OK 73145-9100
DSN: 336-5102

OO-ALC/EM
7276 WADLEIGH ROAD
HILL AFB UT 84056-5137
DSN: 775-2325

466

SA-ALC/EM
307 TINKER DRIVE
KELLY AFB TX 78241-5917
DSN: 945-3100

SM-ALC/EM
5050 DUDLEY BLVD., STE 3
MCCLELLAN AFB CA 95652-1389
DSN: 633-0830

WR-ALC/EM
216 OCMULGEE CT.
ROBINS AFB GA 31098-1646
DSN: 468-1124

ASC/EM
1801 TENTH ST. STE 2
WRIGHT-PATTERSON AFB OH 45433-7626
DSN: 785-3059

ESC/EN-2
5 EGLIN ST (BLDG 1624)
HANSCOM AFB MA 01731-2116
DSN: 478-8127

HSC/EMP
2909 NORTH RD
BROOKS AFB TX 78235-5128
DSN: 240-2346

SMC/SDZB
160 SKYNET ST STE 2315
LOS ANGELES AFS CA 90245
DSN: 833-0293

AGMC/EM
813 IRVING WICK DRIVE WEST
NEWARK AFB OH 43057-7506
DSN: 346-7077

NDCEE Contacts

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Concurrent Technologies Corp
(NDCEE)
1450 Scalp Ave
Johnston PA 15904
814-269-2855 FAX: 814-269-6218

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BRIAN GREENE
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Air Force Support Contractors

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WRIGHT-PATTERSON AFB OH 45433
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abbaca@wpgate1.wpafb.af,mil

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Works environmental matters for ACC/LG

KEITH GLASS
SAF/AQRI
1060 AIR FORCE PENTAGON
WASHINGTON DC 20330-1060
DSN: 227-7579 FAX: 227-4936
WHEN IN CRYSTAL CITY OFFICE
(703) 416-3356 FAX: (703) 416-3329
glassk@aqpo.hq.af.mil

De- icing Contacts By Name at Industry Associations

ADPA
(GEN) RON BECKWITH
Aircraft De-icing Systems Corp
2001 JEFFERSON DAVIS HWY
ARLINGTON VA 22202
703-418-1702 FAX 703-418-0034

NSIA ENVIRONMENTAL COMMITTEE
PETER CARELAS
1025 CONNECTICUT AVE NW
SUITE 300
WASHINGTON DC 20036
202-775-1440 FAX: 202-775-1309

Chair, ADPA Environment Committee
VINCE CICCONE
RASCO
1635-2 WOODSIDE DR
WOODBRIDGE VA 22191
703-643-2952 FAX: 703-497-2905

REGIONAL AIR LINES ASSOCIATION
WALT COLEMAN
1200 19th STREET NW STE 300
WASHINGTON DC 20036-2412
202-857-1170
Commuter airlines in regional airlines assoc

Chair, NSIA Environment Committee
AMMY HOEBER
AMH CONSULTING
3318 SECOND ST SOUTH
ARLINGTON VA 22204
703-271-9527 FAX: 703-271-4267

AIRPORTS COUNCIL INTERNATIONAL
DICK MARCHI
1775 K STREET NW
WASHINGTON DC 20006
202-293-8500
Does technical & enviromental affairs

AAAE
CARTER MORRIS
KATI SCHNELL
DENISE KING
4212 KING ST
ALEXANDRIA VA 22302
703-824-0500 FAX: 703-820-1395

AIR TRANSPORT ASSOCIATION
DON R. MINNIS
1301 PENNSYLVANIA AVE NW
SUITE 1100
WASHINGTON DC20004
202-626-4103
Dir, Airport Plan and Develop. All major airlines belong to ATA Has committee focusing on de-icing.

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AIR TRANSPORT ASSOCIATION OF CANADA
JACK SQUIRES
99 BANK ST STE 747
OTTAWA ONT K1P 6B9
613-233-7727 FAX: 613-230-8648

SAE-G-12 COMMITTEE
JAY MYERS
GINA SAXTON
400 COMMONWEALTH DR
WARRENDALE PA 15096
412-776-4841 ext 7319
FAX: 412-776-0243
Primary SAE contact point.

NATA
FRED WORKLEY
4226 KING ST
ALEXANDRIA VA 22302
8OO-8O8-6282
Training packages approved by FAA. On disc. Being updated.

NATA
ANDREW CEBULA
4226 KING ST
ALEXANDRIA VA 22302
703-845-9000 FAX: 703-845-8176
VP govt-industry affairs

The following are contacts at specific companies involved with de-icing.

Appearance of a company on this list does not mean that the Air Force endorses the product or service sold by that company. All it means is that in our research, we were referred to the company.

The list only provides a starting point for Air Force people working de-icing problems to begin seeking solutions.

3M
WARREN VOLLMAR
612-733-0384
Works with NASA Ames

AIRCRAFT DE-ICING SERVICES
7850 HARRY B COMBS PARKWAY
DENVER IAP
DENVER CO 80249
303-342-5600 FAX: 303-342-5653

AIRCRAFT DE-ICING SYSTEMS INC
(GEN) RON BECKWITH
2001 JEFFERSON DAVIS HWY
ARLINGTON VA 22202
703-418-1702 FAX 703-418-0034

AIREFFRIGERATION SYSTEMS
BILL YOUNG
1351 HARBOR BAY PKWY STE 2000
ALAMEDA CA 94502
(510) 748-1100 FAX 510-748-1110

ALLIED SIGNAL AEROSPACE
DAN FOLEY
AEROSPACE EQUIPMENT SYSTEMS
2525 W 190TH STREET
TORRANCE CA 90509
310-512-1390

ALLIED SIGNAL AEROSPACE
BOB SHEPARD
% NAVICP BLDG 1 ROOM 2222
700 ROBBINS AVE
PHILADELPHIA PA 19111
215-697-3995

469

ALLIED SIGNAL AEROSPACE
JOHN STANKO
AEROSPACE EQUIPMENT SYSTEMS
2525 W 190TH STREET
TORRANCE CA 90509
310 512 4613

AMR COMBS
RICHARD LEAHY
DENVER INT'L AIRPORT
7850 HARRY B COMBS PARKWAY
DENVER CO 80249
303-342-5654 FAX: 303-342-5653
recycle systems

ARCO CHEMICAL CO
ANDREW LEWIS
3601 WESTCHESTER PIKE
NEWTON SQUARE PA 19073
610-359-2264 FAX: 610-359-7207
De-icing fluid manufacturer

A/S ROULUNDS FABRIKER
HESTERHAVEN, DK-5260 ODENSE S
DENMARK
45-63-11-50-00 FAX: 45-66-11-23-80

ASCENT TECHNOLOGIES GROUP
DAVID NEWMAN
BRIDGETTE BARKER
ONE MILL ST
PARISH NY 13131-9715
315-625-7299 FAX: 315 625-4226

ATHEY PRODUCTS CORP
WES BRANT
1839 S MAIN ST
WAKE FORREST NC 27587
919-556-5171 FAX: 919-556-0122
airport sweepers

AUGIAS
JIM McDONALD
1381 PARK CENTER RD
HERNDON VA 22071
703-471-4952 FAX: 301-229-5916

AVIATION ENVIRONMENTAL INC
LARRY HINEBAUGH
4335 S. INDUSTRIAL RD STE 400
LAS VEGAS NV 89103
800-788-6450 FAX: 702-262-2994

AVIATION ENVIRO COMPLIANCE CO
LEE WILLIAMS
DAYTON OH
513-294-1861

B A LEISCH ASSOCIATES
HARRY SUMMITT
13400 15TH AVE NORTH
MINNEAPOLIS MN 55441
612-559-1423 FAX: 612-559-2202

BATTS INC
JOHN BATTS Sr
JOHN BATTS Jr
BOX 1
108 S MAIN ST
ADVANCE IN 46102
(317) 676-5123 FAX: (317) 676-5275

BF GOODRICH
DAVE SWEET
339-374-3707

BG PRODUCTS INC
GALEN MYERS
PO BOX 1282
WICHITA KS 67201
316-265-2686 FAX: 316-265-1082

BIOFILTRATION SYSTEMS INC
TOM CANNON
1800 SECOND ST STE 808-13
SARASOTA FL 34236
(813) 953-5200 FAX: 813-953-5353

BIOTRONIC TECHNOLOGIES
BERNARD BEEMSTER
W226 N555B EASTMOUND DR
WAUKESHA WI 53186
414-896-2650 FAX: 414-896-2644

CANMET MINERAL LAB
BOB HARGREAVES
613-992-7782

CATALYST and CHEMICAL SERVICE
JOHN GAUGHAN
2100 MUIR WAY
BEL AIR MD 21015
410-569-1200 FAX: 410-569-1202
aircraft de-icing and cleaning system

CENTECH GROUP INC
JIM HAMILTON
4200 WILSON BLVD STE 700
ARLINGTON VA 22203
]703-812-5363 FAX: 703-525 2349
De-icing programs

CH2M HILL
GINGER EVANS
6060 SOUTH WILLOW DRIVE
GREENWOOD VILLAGE CO 80111
303-771-0900
Airport deicing operations

COASTAL FLUID TECHNOLOGIES
MIKE GROTEFEND
PO BOX 81577
LAFEYETTE LA 70598-1577
(318) 261-0796 FAX: (318) 261-0797

CRYOTECH DE-ICING TECHNOLOGY
6103 ORTHWAY
FORT MADISON IA 52627
319-372-6012 FAX:
800-346-7237

CRYOTECH DE-ICING TECHNOLOGY
KEITH JOHNSON
3550 GENERAL ATOMICS CT
SAN DIEGO CA 92186-9784
619-455-3446 FAX: 619-455-4217

CRYOTECH DE-ICING TECHNOLOGY
BOB STRAWN
TONY MYHRA
11100 ASH STE 208
LEAWOOD KS 66221
8OO-255-0401 FAX: 913-491-1621

DAVID CLARK CO
STEPHEN KENNEDY
360 FRANKLIN ST
WORCESTER MA 06150
508-756-6216 FAX: 508 753 5827

DELTA ROCKY MOUNTAIN PETRO
MARK ALDRICH
9155 BOSTON ST
HENDERSON CO 80640
303-289-4483 FAX: 303-287-2541

ECCO INC
JOHN BRADFORD
3601 C STREET STE 1414
ANCHORAGE AK 99503
800-301-4311 FAX: 907-563-7926

ECOLOGY AND ENVIRONMENT INC
PATRICIA MALINOWSKI
368 PLEASANT VIEW DR
LANCASTER NY 14086
716-684-8060 FAX: 716-684 8060

EFX SYSTEMS
ROGER OWENS
1300 SHANES DR
WESTBURY NY 11590
516-997-2100 FAX: 516-997-2129
Biological technologies

ELGIN SWEEPER CO
1300 W BARTLETT RD
ELGIN IL 60121-0537
708-741-5370 FAX: 708-742-3035

ENERGETICS
TERRY BATES
7164 COLUMBIA GATEWAY DR
COLUMBIA MD 21046
410-290-0370 FAX: 410-290-0377

ENVIRONMENTAL ENGINEERING CENTER
North Dakota Env Research Center
FRANK BEAVER
701-777-5125 or off DSN 362-1110
Tied in with U of ND Studying distillation of glycol

EQ-ENVIRONMENTAL QUALITY CO
PAT SULLIVAN
1349 S HURON ST
YPSILANTI MI 48197
313-485-6460 FAX: 313-485-6493

ENVIROTECH SERVICES
MATT DURAN
PO BOX 275
WESTMINSTER CO 80030(303)
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EPOKE A/S
LARS MATHIASEN
VEJENVES 50 ASKOV
POSTBOX 230
DK-660 VEJEN **DENMARK**
45 76 96 22 00 FAX: 45 75 36 38 67

FEDERAL SIGNAL
BILL ACKENDORF
51 FERNWOOD LANE
GRAND ISLAND NY 14072
716-773-7057 FAX: 716-773-8054

FMC-ORLANDO
CLIFF FOSTER
DAVE PHILLIPS
7300 PRESIDENTS DR
ORLANDO FL 32809
407-850-2844 FAX: 407-850-2839
Engineer, de-ice equipment

FMW INTERNATIONAL INC
BOB MUELLER
77 WEST PORT PLAZA STE 304
ST LOUIS MO 63146
314-434-9747 FAX: 314-434-9713

FOSTER-MILLER INC
DR HARRIS GOLD
CAROLYN WESTMARK
195 BEAR HILL RD
WALTHAM MA 02154-1196
617-684-4419 FAX: 617-290-0693
Carolyn Westmark worked de-icing at Wright Lab while on active duty.

G. VESTERGAARD A/S
BILLY VESTERGAARD
SKULLEBJERG 31, GEVNINGE
DK-4000 ROSKILD
DENMARK
011-454-642-2222
Danish company manufactures efficient de-icing trucks

GLYCOL SPECIALISTS INC
5915 N BROADWAY
DENVER CO 80216
303-292-2000 FAX: 303-292-0429

HNTB CORP
JAMES PARKS
111 MONUMENT CIRCLE STE 1200
INDIANAPOLIS IN 46204
317-636-4682 FAX: 317-633-0505

HOECHST CANADA INC
KURT ENGLEHARDT
4045 COTE VERTU
MONTREAL QUEBEC H4R 1R6
CANADA
(514) 333-3630 FAX: 514-333-3751

HUDSON GENERAL
IAN SHARKEY
AIRWAY CENTER
5915 AIRPORT RD STE 400
MISSISSAUGA ONTARIO L4V 1T1
CANADA
905-676-0511 FAX: 905-676-0533

INDEPENDENT EVALUATORS
RAY VASELICH
8804 LAKEHILL DR
LORTON VA 22079-3211

INLAND TECHNOLOGIES INC
DARYL GOLBECK
CRAIG COLLINS
5925 AIRPORT RD STE 200
MISSISSAUGA, ONTARIO L4V 1W1
CANADA
(905) 405-6222 FAX: 905-672-8630
Environmental support managers

INTERNATIONAL AUTOMATED SYSTEMS
JORGEN S BILDSOE
2233 HAMLINE AVE N STE 220
ST PAUL MN 55113
(612) 636-3853 FAX: (612) 636-0309

JAYCOR
BOBBIE THOMPSON
4035 COL GLENN HWY ste 100
BEAVERCREEK OH 45431
(513) 427-9690 FAX: (513) 427-9673
Research and recommend de-icing projects

LABAT-ANDERSON INC
EVELYN MCDONALD
8000 WESTPARK DR STE 400
MCCLEAN VA 22102
703-506-1400 FAX:703-506-4646
HSC de-icingstudy

LANDOLL CORP
TOM JOYCE
1900 NORTH ST
MARYSVILLE KA 66508
913-562-5381 FAX: 913-562-5381
Manufacturer of de-icing equipment

MERCURY GSE
TIM GARVIN
135 SHELDON ST
EL SEGUNDO CA 90245
310-335-0082 FAX: 310-335-0155

MOBILE PROCESS TECHNOLOGY
FRANK CRAFT
2070 AIRWAYS BLVD
MEMPHIS TN 38114
901-744-1142 FAX: 901-743-2361

MOBILE PROCESS TECHNOLOGY
SCOTT CARPENTER
800-238-2038

NORTH AMERICAN BIOINDUSTRIES CORP
BOB LITZAU
3068 S CALHOUN RD
NEW BERLIN WI 53151
414-796-8448 FAX:
800-395-8070
Working with WI ANG

OCTAGON PROCESS INC
JANE HINKLE
THE MARKET PLACE
725 RIVER RD
EDGEWATER NJ 07020
201-945-9400 FAX: 201-945-1203
Company manufactures de-icing fluids and chemicals

OGDEN ENVIRONMENTAL AND ENERGY SERVICES
JERRY SHOEMAKE
MIKE COCHRANE
3325 PERIMETER HILL DR
NASHVILLE TN 37211
615-333-0630 FAX: 615-331-4715
Works water issues for ANG

OGDEN ENVIRONMENTAL AND ENERGY SERVICES
DOUG NOEL
690 COMMONWEALTH CENTER
11003 BLUE GRASS PARKWAY
LOUISVILLE KY
502-267-0700 FAX: 502-267-5900
dnoel@nc5.infi.net
Works water issues for ANG

OLD WORLD INDUSTRIES
MIKE REED
4065 COMMERCIAL AVE
NORTHBROOK IL 60062-1051
847-559-2085 FAX: 847-559-2038

PHOENIX BIOSYSTEMS
DR JOE RUOCCO
310 N FIRST
PO BOX 397
COLWICH KS 67030
(316) 796-0900 FAX: (316) 796-0944

PROCESS TECHNOLOGIES INC
JOHN CHEW
40 CENTRE DR
ORCHARD PARK NY 14127
(716) 662-0022 FAX: 716-662-0033

PURE MAT RECOVERY SYSTEMS
JACK HENNESSY
PO BOX 22203
PHEONIX AZ 85028
602-996-4500 FAX: 602-837-3799

RICHMOND DE-ICER CO
DENYSE DU BRUCQ
51 WILLARD ST
QUINCY MA 02169
(617) 646-5056 FAX: (617) 471-7561

RVSI
CARL BARANISHYN
516-273-9700
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SAIC
CHRISTINA CARLSON
11251 ROGER BACON DR
RESTON VA 20190
(703) 318-4596 FAX: (703) 736-0826

SIMON AVIATION GROUND EQUIP
BILL DEMPSEY
55 OLD 56 HIWAY
OLATHE KS 66061-2110
913-780-0300 FAX: 913-782-8675
Manufactures de-icing trucks

SMITH AND LOVELESS INC
GARY WOTLI
3240 N BROADWAY
ST LOUIS MO 63147-3515
314-621-2536 FAX: 314-621-1952

SPAR AEROSPACE LTD
CHRIS BUTT
9445 AIRPORT RD
BRAMPTON ONTARIO L6S 4J3
CANADA
905-790-4497 FAX: 905-790-4430
recycle systems

SWEEPER JENKINS
TOM BALL
2800 N ZEB RD
DEXTER MI 48130
800-456-7100

THOMSEN PRODUCTS INC
TORBEN ZERLANG
ALICIA DAWSON
604 HAYDEN STATION RD
WINDSOR CT 06095
(203) 688-8331 FAX: 203-683-2314

TYMCO
DON BLASCHE
PO BOX 2368
WACO TX 76703
817-799-5546 FAX: 817-799-2722

UNION CARBIDE CORP
DANIEL GARSKA
PO BOX 8361
SOUTH CHARLESTON WV 25303
304-747-4631
Tech mgr for ADAF

VACTOR MANUFACTURING INC
STEVE BAKER
1621 SOUTH ILLINOIS ST
STREATOR IL 61634
815-672-3171 FAX: 815-672-2779

VELCO
BARRY JOHNSON
2804 W SAN RAFAEL ST
TAMPA FL 33629
813-251-2104 FAX: 813-251 2101

WESTON
BILL FREEMAN
1 WESTON WAY
WEST CHESTER PA 19380-1499
610-701-3616 FAX: 610-701-7597

WRIGHT TECHNICAL NETWORK
DR BILL HIRT
3155 RESEARCH BLVD SUITE 201
DAYTON OH 45420-4015
(513) 253-0217 FAX: (513) 253-7238

ZENON ENVIRONMENTAL SYSTEMS
DICK SMALLWOOD
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VIRGINIA BEACH VA
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Complete fluid capturing service.
Company certified ramp meets local environmental law

US Airlines De-icing Contacts.
This listing also includes contacts at city airports

FED EX
MICHAEL FINK
PO BOX 727
MEMPHIS TN 38194
901-360-3146
Flight manager

FED EX
JIM GWALTNEY
3796 LAMAR AVE
MEMPHIS TN 38118
901-2226 8271 FAX: 901-224-8278
global operations control manager

UNITED AIRLINES
MURRAY KUPERMAN
MAINTENANCE OPERATIONS
SAN FRANCISCO INT'L AIRPORT
SAN FRANCISCO CA 94128-3800
415-634-5149 FAX: 415-634-7117
Chairman, SAE G-12 fluids committee

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DELTA AIRLINES
WARNER UNDERWOOD
HARTSFIELD AIRPORT
ENGINEERING DEPT 563
ATLANTA GA 30320
404-714-3151 FAX: 404-714-3304
SAE G-12 group leader

AMERICAN AIR TRANSPORT
PHILIP McBRIDE
OHARE INTERNATIONAL AIRPORT
CHICAGO IL 60666
312-686-6550 FAX: 312-686-4907
Maintenance manager

O'HARE INT'L AIRPORT
FRANK GRIMALDI
DEPT OF AVIATION
TERMIMAL 2 PO BOX 66142
CHICAGO IL 60666-0142
312-686-2255 FAX: 312-686-2303

RHODE ISLAND AIRPORT CORP
JAMES ZISIADES
TF GREEN AIRPORT
WARWICK RI 02886-1533
401-737-4000 x237 FAX:401-739-4204

DAYTON INTERNATIONAL AIRPORT
DONNA GORBY-LEE
VANDALIA OH 45377
513-454-8212
Environmental compliance coordinator

DAYTON INTERNATIONAL AIRPORT
DAVID MASON
VANDALIA OH 45377
513-454-8208
De-icer spill into watershed.

PORTLAND INT'L AIRPORT
BILL LONG
BOX 3529
PORTLAND OR 97208
503-335-1134 FAX: 503-335-1124

SYRACUSE DEPT OF AVIATION
CHARLES EVERETT
HANCOCK INT'L AIRPORT
SYRACUSE NY 13212
315-454-3263 FAX 315-454-3263

CONTACTS AT COLLEGES AND UNIVERSITIES

GEORGIAN COLLEGE
TED SYME
ONE GEORGIAN DRIVE
BARRIE ONTARIO L4M 3X9 **CANADA**
705-728-1968 x1424 fax:705-722-5175

UNIVERSITY OF COLORADO
DR DOBROSLAV ZNIBARCIC
DR MARK HERNANDEZ
CIVIL ENGINEERING DEPT
BOULDER CO 80309
303-492-7577 FAX: 303-492-7317

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